USAID FIRMS PROJECT

Capacity Need Assessment of Agricultural Implements Manufacturing Units

May 2012

This publication was produced for review by the USAID. It was prepared by Hasan Haider for an assignment commissioned by Chemonics International under the USAID Firms Project.

USAID FIRMS PROJECT

Capacity Need Assessment of Agricultural Implements Manufacturing Units

Data Page

Contract Number:	GBTI II Task Order No. EEM-4-07-07-00008-00
Contractor Name:	Chemonics International, Inc.
Name of the Component:	Value Chain Development (VCD)
USAID Technical Office:	Office of the Economic Growth and Agriculture; USAID Pakistan
Date of Report:	May 30, 2012
Document Title:	Capacity Need Assessment of Agricultural Implements Manufacturing Units
Author's Name:	Hasan Haider
Editing:	Zehra, M. Tahir, S. (USAID Firms Project)
SOW Title and Work Plan & Action ID:	USAID Pakistan FIRMS Project Work Plan Level 24670 Action 5881, SOW 1845>
Project Area:	Nationwide -Pakistan

Abstract

This report evaluates the capacity need assessment of agricultural implements manufacturing units in various clusters across the state. The purpose is to develop a value chain so that proper interventions could be taken in order to optimize the production of the promising agricultural sector.

Acronyms

AC	Alternating Current
AMRI	Agriculture Machinery Research Institute
BDSP	Business Development Support Providers
BPR	Business Process Re-engineering
CAMI	Center for Agriculture Machinery Industries
CEO	Chief Executive Officer
CFC	Common Facility Center
CFTs	Cross Functional Teams
CNC	Computerized Numeric Control
CR sheets	Cold Rolled Sheets
CRTs	Cost Reduction Teams
DC	Direct Current
EDB	Engineering Development Board
GDP	Gross Domestic Product
GST	General Sales Tax
IE	Industrial Engineering
ISO	International Standardization Organization
KG	Kilogram
KPK	Khyber Pakhtun Kha
LEDs	Light Emitting Diodes
LFC	Lab Facilitation Center
OEE	Overall Equipment Efficiency
OJT	On Job Training
PAMIMA	Pakistan Agriculture Machinery and Implements Manufacturing Association
PARC	Pakistan Agricultural Research Council
PITAC	Pakistan Industrial Technical Assistance Center – Ministry of Industries
PMI	Pakistan Machinery Institute
PPEs	Personal Protective Equipments
PSIC	Punjab Small Industries Corporation
PSQCA	Pakistan Standard & Quality Control Authority
PVTC	Punjab Vocational Training Council
QA	Quality Assurance

QC	Quality Control
QCC	Quality Control Circle
QMS	Quality Management System
R & D	Research & Development
SCM	Supply Chain Management
SME	Small & Medium Enterprise
SMEDA	Small and Medium Enterprise Development Authority
SOP	Standard Operating Procedure
SOW	Scope Of Work
Super 5 S Kaizen	Sorting, Simplifying, Shine, Standardize, Self Discipline
SWOT	Strength, Weaknesses, Opportunities and Threats
TEVTA	Technical Education and Vocational Training Authority
TNA	Training Need Assessment
TPM	Total Productive Maintenance
TUSDEC	Technical Up-gradation & Skill Development Company
US $	United State Dollars
USA	United State of America
USAID	United States Agency for International Development
USP	Unique Selling Point
VCD	Value Chain Development
WIP	Work in Process

Table of Contents

Executive Summary

Agriculture is one of the largest sectors of Pakistan, accounting for over 21 percent of GDP, providing employment to 45 percent of the country's total labor force and contributing significantly to Pakistan's total export. The sector serves as a large market for industrial products such as fertilizer, pesticide, machinery and agriculture implements. However, productivity and yield in the sector are far below the international standards and benchmarks, especially related to mechanization and modernization.

Introduction of farm mechanization by enhancing the availability of effective and efficient agriculture implements at reasonable prices is one such step to increase the productivity of small and medium sized farms. Agriculture Implements cover a very wide range and have different functions, design and configuration with a wide range of prices. The farm machinery and implements manufactured in Pakistan can be divided into three broad categories: self propelled, tractor drawn agriculture implements and hand Tools (manual or animal drawn). USAID Firms Project has narrowed down its focus on tractor drawn agricultural implements, keeping in mind the resource constraints.

The major determinants of growth of the agricultural implements in Pakistan include sales of tractor in the country, because with each tractor, the buyer also buys some agriculture implements. The second is the purchasing power of farmers, and third is the price of implements. To impart growth to agricultural implements manufacturing sector, price competitiveness is highly required therefore interventions that enhance cost competitiveness of the units are required.

Implements that are manufactured in Pakistan can be grouped in a broader way, i.e. with respect to their usage/specialized operations. The categories can include Tillage implements; Land and Seed-bed preparation implements and tools; sowing implements; plant protection implements; harvesting, reaping and thrashing machines; Processing and value addition machinery & Transportation etc. From the census conducted by Federal Government of Pakistan, one can estimate the mechanization trend and growth rate of various implements to find out where this sector is moving.

In Pakistan, Agricultural implements and tools are being manufactured mostly in Punjab which caters to the needs of other provinces too. There are around 500 manufacturing units in Punjab, with Faisalabad, Daska, Okara and Mian Chunnu being the major clusters, and a few in KPK and Sindh also. The prevalent marketing and sales system of agricultural implements can be termed as a combination of push system and pull system based on referral. The farmer of end user visits the manufacturer to buy the implements usually based on referral.

The value chain of agricultural implements is relatively short and simple. The final product reaches end customer after changing a few hands and going through a few value addition stages, starting from the suppliers of raw materials to standard parts manufacturers, who serve as vendors as well as assemblers, and finally to fabrication/assembling units from where they are sold to exporters and farmers. The industry can be categorized into the following major groups: Implement fabrication and assembly units, Raw material suppliers, specialized components manufacturing units & Tools/patter/dye makers. The important players in value chain are as follows: Raw material supplier, Provincial Government Agriculture Departments, PAMIMA, Business Development Services Providers (BDSP) and Exporters.

The world trade market of agricultural implements is over US $ 4 billion. Most of this market is for high end standardized products but due to affordability issues in poor agricultural countries, a market for low end products also exists. The world trade market for low end products is around US$ 500 million. Pakistan is exporting farm machinery and agricultural implements to some neighboring countries as well as third world countries of Africa, by operating in the lower price segment. India, China and Turkey are the major competitors for Pakistan. The export of agriculture implements is not stable because these products are not being sold as branded products, and due to this, implements manufacturers are not reaping the benefits of current exports.

Numerous government, semi-government and autonomous support agencies are working in Pakistan to provide technical, engineering and management support to agricultural implements manufacturing sector as well as its vendor. These can be broadly categorized into 2 categories: The first is agricultural implements specific agencies/centers, such as Center for Agriculture Machinery Industries in Mian Channu, Farm Machinery Institute Islamabad, Agriculture Machinery Research Institute Multan, Agriculture Mechanization Research Cell (Tando Jam Sindh), & PCSIR Center Daska. The other is General Agencies which provide various services and assistance to agriculture implements manufacturing units directly or indirectly, such as EDB, TUSDEC, PITAC, SMEDA and PSIC.

A SWOT analysis of the agriculture implements sector would show that the major strengths of the sector are that it is meeting demand of such a large domestic market; it is labor intensive and not high-tech, it requires medium investment and machinery with low accuracy and its main components are locally available. The weaknesses are that sale is correlated to sales of tractors, longer shelf life make replacement sales low, existence of cut throat competition and non existence of quality control systems and standards. Opportunities include possibility of export to regional countries, ability to grow and meet requirements of low end export market, and joining of enterprises for international branding etc, whereas the threats are price escalations of raw material, need for ISO-9001 QMS to enter high end segments, poor law and order situation etc.

The sector is facing many constraints which are limiting its growth. Sector specific constraints include lack of availability of raw material, access to capital/affordable finance, policy/enabling environment reforms and access to new export markets. Unit specific constraints include productivity related constraints, lack of access to new technologies and export market & less capacity of labor and management.

Some of the important operations involved for agriculture implements include shearing, cutting, pressing, gas cutting, sheet metal fabrication, grinding etc. Major issues in production and operations include raw material issues such as high cost of steel, and lack of availability of steel alloys and other alloys. The other main issue is the energy crisis which casts adverse effect on the overall cost structure of product as well as the sector's competitiveness.

1. Introduction

Agriculture is the mainstay of Pakistan's economy, contributing over 21% of GDP and providing employment to 45% of the labor force. The agricultural sector of Pakistan can't realize its full potential without the development of the agriculture implements manufacturing sector, which is presently at a very rudimentary stage and has huge potential for improvement. Technology up-gradation, provision of on-site technical assistance and capacity building of manufacturers to produce standardized products with process standardization as well as process optimization would lead to higher productivity and cost effectiveness (less rejection, rework and wastage, less energy consumption) and that would increase the cost competitiveness of the enterprises and in turn the sector.

In this backdrop, USAID Firms Project chose this promising sector to develop the value chain with appropriate interventions. To start with, a short term consultant was brought on board to undertake the capacity need assessment of the manufacturing units working in various clusters.

The consultant visited various manufacturing units of Daska, Okara, and Faisalabad; interviewed their management, supervisors, and shop-floor workers and physically observed all the operations and manufacturing processes, with respect to manpower, machines, materials, methods, quality control, working environment, and current capabilities. The objective was to collect qualitative and quantitative data and information necessary to identify and assess the current performance gaps, productivity and the readiness to bring about the required changes. Furthermore, on the basis of this analysis, the consultant had to recommend the areas of improvement along with the required appropriate interventions to be undertaken.

The consultant identified and evaluated the productivity and capacity gaps by benchmarking the current manufacturing systems and practices with good manufacturing practices (GMP) adopted by similar industries / counterparts in other countries. Furthermore, on the basis of this analysis, the areas of improvement have been identified along with commercially feasible interventions and action plans, especially where capacity building of the units through technical assistance and on-job training can produce significant impact.

The objective of this need assessment is to serve as a stepping stone to the value chain development of this sector in order to open new windows of opportunities for Pakistan's agricultural implements manufacturers in the domestic as well as international front.

The findings contained and cited in this document are derived primarily from personal interviews with industry players and other stakeholders, as well as on-site observations and live assessment of various manufacturing units.

In this report, findings are followed by the strategy and recommendations for sector development. Based on the findings and observations, the consultant recommends USAID Firms Project to develop 8-12 model agricultural implements manufacturing units. Due to intense competition, the other players would automatically follow these units by emulative behavior, and that would trigger major change in the sector.

The conclusions and recommendations contained in this report stem from the compilation of this body of material, thoughts and discussions with the experienced members of Firms Project staff, experts of the sector, and the consultant's experience in the light engineering sector.

1.1 Agriculture Sector of Pakistan

Agriculture sector is one of the largest sectors of Pakistan, accounting for over 21 percent of GDP. About 62% of the country's population resides in rural area who is directly or indirectly involved with agriculture sector to earn their livelihood. Furthermore, the sector is providing employment to 45 percent of country's total labor force[1] and is contributing a significant percentage to Pakistan's total export. It is generally believed that agriculture sector's strong linkages with the rest of the economy are not fully captured in the statistics. The sector is not only a primary supplier of raw materials to downstream industry, but also serves as a large market for industrial products such as fertilizer, pesticide, machinery and agriculture implements.

The sector's role in economic growth of Pakistan is well established by all standards and justifies prioritizing multi-lateral interventions by public, private as well as development sector. Despite its critical importance to export, labor absorption capacity, economic growth, incomes and food security, the agriculture sector could not realize its true potential even after 65 years of independence. Productivity and yield are far below than the international standards and benchmarks, which necessitate undertaking multipronged strategy, especially related to mechanization and modernization, in various elements/sections of agriculture sector value chain as well as its sub-value chains.

[1] *Website of ministry of agriculture (www.minfal.gov.pk)*

2. Sectoral Analysis Agricultural Implements Manufacturing Sector of Pakista

Introduction of farm mechanization by enhancing the availability of effective and efficient agricultural implements at reasonable prices is one such step to increase the productivity of small and medium sized farms. Well-manufactured implements not only contribute to the cropping intensity and diversification of agriculture but also enable efficient utilization of inputs such as fertilizers, pesticides, seeds and irrigation water. Agriculture implements manufacturing is an under developed sector with the exception of tractor assembling and the manufacturing of its parts. Up till now, agriculture implements manufacturing units are practicing crude and rudimentary manufacturing processes under highly nonprofessional management.

Agriculture implements cover a very wide range of products with different functions, design and configuration along with wide range of prices starting from a few hundred rupees to hundreds of thousands of rupees. The farm machinery and implements, manufactured in Pakistan can be divided into the following three broad categories with respect to their size:

a) Self propelled
b) Tractor drawn agricultural implements (directly or through power take-off -- PTO shaft or engine / motor driven)
c) Hand tools / manual or animal drawn

In view of duration of the project, resource constraints, and potential of improvement, USAID Firms Project has narrowed down its focus on tractor drawn agricultural implements, which has been the scope of this assignment.

Growth Determinants of the Sector
In Pakistan, manufacturing sector is facing a lot of challenges, yet the agricultural implements manufacturing sector is growing. The major determinants of the growth of this sector are:

a. **Sales of the tractor in the country:** A strong correlation exists between sales of tractor and agriculture implements. With each tractor, buyer also buys some agriculture implements because in the country, the trend of renting out standalone implements and farm machinery in a formal way could not take roots, with the exception of tractor, combine harvester and some other expensive machines. Now, due to escalating prices of implements, some businessmen have started renting out even small implements in Daska city. Last year government imposed 16% General Sales Tax (GST) on tractors which dampened their sales. Recently, government has reduced GST to 5%. Likewise, government included agricultural implements manufacturing sector in 16% GST net last year. Still it is enforced despite all the resistance put forward by the sector. With the exception of a few major players, majority did not get registered with government for sales tax and are doing undocumented sales.

b. **Purchasing power of farmers:** Farmers buy implements when they have surplus money, which comes from the bumper crops and the good price, the crops fetch in the market. Last year, due to bumper cotton and potato crops, implements' sales went up. This year, sales are somewhat at the lower side due to poor prices of major crops.

c. **The price of implements:** Due to inflation and depreciation of Pak Rupee, the prices of raw material, utilities bills and labor charges are escalating, which in turn causes the high prices of implements. To top it all, last year government imposed 16% GST on agricultural implements. Naturally, such overblown prices have gone beyond the buying power of many farmers.

Growth is essential to develop any sector. To impart growth to agricultural implements manufacturing sector, price competitiveness would be highly required. Therefore, such interventions are required that can enhance the cost competitiveness of the units.

2.1 Product Range

Pakistan is a country of many crops; each has its own season and peculiar requirements. Each crop requires various operations during its production, harvest and post harvest stages and accordingly specialized implements and tools are required.

Implements, being manufactured in Pakistan can be grouped in a broader way, as under, with respect to their usage/specialized operations.

a. Tillage implements: Plough, harrow, cultivator, rotary tiller
b. **Land and seed-bed preparation implements and tools:** Ridger, leveler (kraha), tramper, dole maker, paddy puddlers and cage wheels
c. Sowing implements: Seed drill machine, seed-cum-fertilizer drill, zero tillage drill, bed planter, potato planter, sugarcane planter, paddy transplanted
d. Pesticide spray / plant protection implements /equipment: Knapsack sprayer, tractor operated boom sprayer, pesticide duster, hoes, paddy weeders
e. **Harvesting, reaping, and thrashing machines / implements:** Reapers, threshers, manual tools (sickles), maize thrasher
f. Processing and value addition machinery: Driers for various products, sugarcane crushers, rice shellers, grain graders, chaff cutter
g. **Transportation / haulage Equipment:** Trolley for tractor within the implements, there are variants and modifications to meet the various crop requirements. The Vice Chancellor of University of Agriculture Faisalabad informed that there are nine types of drills, which are being manufactured.

The Federal Government of Pakistan (Statistical Department) conducts agriculture machinery census after every ten years, to collect data about the number and kind of machines and implements being used in the country. From the census figures, one can estimate the mechanization trend and growth rate of various implements, to find out the direction where this sector is moving. In Annexure, the list of top 20 agricultural implements, being used in Pakistan has been provided by extrapolation of previous census (2004) data with the growth rate of each implement.

2.2 Agricultural Implements Manufacturing Clusters

In Pakistan, agricultural implements and tools are being manufactured mostly in Punjab and this province is catering to the needs of other provinces also. In Punjab, more than 500 units[2] are manufacturing agricultural implements, and these units are scattered in almost every district of Punjab. Faisalabad, Daska (Sialkot), Okara and Mian Chunnu (Khanewal) are major clusters. In Khabar Pakhton Kha (KPK) and Sindh province, few manufacturers are concentrated in Shabqadar (KPK), Nawabshah (Sindh) and Hyderabad (Sindh) respectively.

2.3 Current Marketing and Sales System

The prevalent marketing and sales system of agricultural implements can be termed as a combination of push system and pull system based on referral. In true sense, this pull system is not based on marketing or advertisement. Since each agriculture implement is worth thousands of rupees, therefore it is well thought and not an impulsive decision. The farmer or end user visits the manufacturer or its dealer to buy the implements usually based on referral. Push type marketing, in its true sense, does not exist in sector because personal selling or structured dealers network do not exist.

The small manufacturers manufacture only on confirmed orders, and usually such orders takes days and in certain cases months to comply with. The medium sized manufacturer's usually manufacture a few pieces of those implements in advance, which are in demand due to the crop season, and put at display at their own workshops and in certain cases at their showrooms. Owing to this arrangement, the farmer's can buy the implements then and there.

The large manufacturer's have an informal network of dealers in various cities. Usually these dealers have small workshops or are spare parts shop keepers. Manufacturers usually provide a few pieces to their dealers on credit, and they put these implements on display. Dealers in 99% cases sell these implements to farmers on cash.

These network of these dealers also plays an important role in annual production planning because manufacturer inquire about the sales potential of each implement from each and every dealer and the dealer provides a ballpark figure on the basis of last year's sales volume. These dealers take care of post-sale warranty period by rectifying the troubles by themselves or by inviting specialized mechanics from the manufacturers.

2.4 Value Chain and Flow of Material and Product

The value chain of agricultural implements is relatively short and simple (Figure 1) and the final product reaches the end customer after changing a few hands and going through a few value addition stages. The value chain starts form the suppliers of raw materials, who supply raw material (steel and other metals bars, sheets, angles etc) to standard parts / components manufacturers, who serve as vendors, as well as assemblers / fabricators. From vendors, the finished parts go to fabrication / assembling units, where final products come into existence and are sold to exporters and farmers (end customers).

[2] *These units are not huge factories but large sized workshops.*

The industry can be categorized into the following major groups:

2.4.1 Implement fabrication and assembly units

This is the core group of agriculture implements manufacturers. They are involved in the fabrication of various types of tillage implements, land preparation implements, sowing implements, harvesting and thrashing machines, trolleys of tractors.

They buy the specialized parts (forged, heat treated, casting parts) from vendors and standard parts (bearing, chains, nut bolts etc) and structural steel & alloys from middlemen (commission agents, distributors, and wholesalers). There is hardly any manufacturer who directly buys form steel mills or directly import from other countries, due to poor economies of scale.

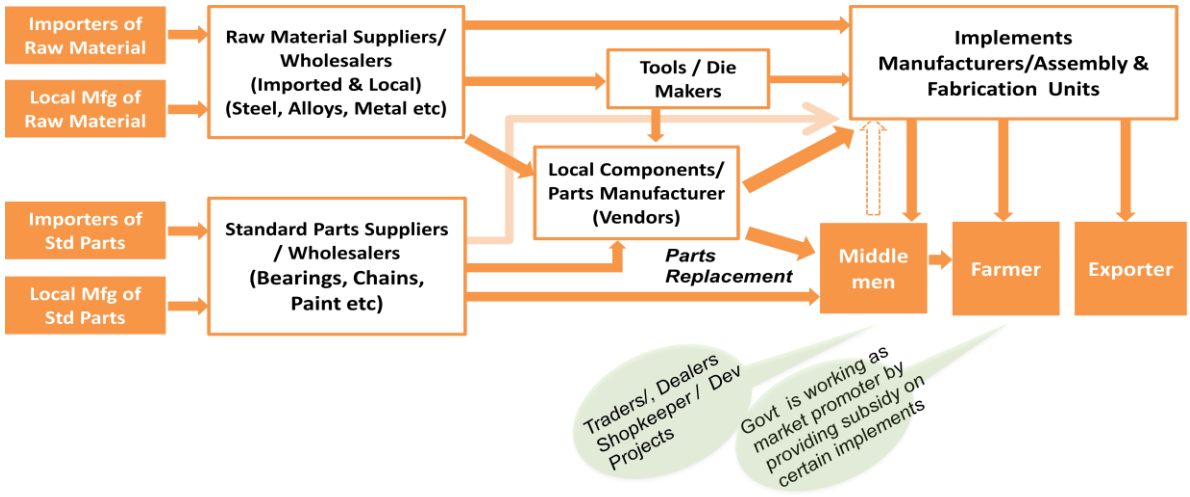
Majority of manufacturers are manufacturing a variety of implements (broad range of implements) as per customer demands, with the exception of a few, which have one or a few specialized products.

2.4.2 Raw material suppliers / standard parts suppliers

Small, medium and large suppliers are working in each major cluster of agriculture implements. They sell steel bars, steel sheets, various alloys etc. to fabricators / assemblers.

There are some other types of suppliers, who deal in standard parts (imported as well as local) such as bearings, gears, chains, paints, nut bolts, etc. Many suppliers have overlapping products and they trade both in raw material as well as standard parts.

Figure 1 Suppliers in Agriculture Implements



2.4.3 Specialized components manufacturing units / vendors

Some vendors manufacture the parts / components such as cultivator spring, cultivator shovel (phala), tiller / cultivator tynes, and harrow discs. Usually such components require specialized operations / process such as heat treatment, forging, casting (steel, aluminum, zinc) etc., so specialized vendors have developed with the passage of time.

Small foundries supply casting parts to manufacturers. Parts of threshers, reapers and some other machines/implements are cast in various cities. Likewise, forged parts are extensively used in some implements and the specialized vendors are working in various cities to manufacture such parts.

The heat treatment method is very crude and is performed by heating the job in furnace and then quenching in the oil without any care about its suitability, quality or grade. Disc, Shovel, Tyne etc. are being manufactured by heat treatment.

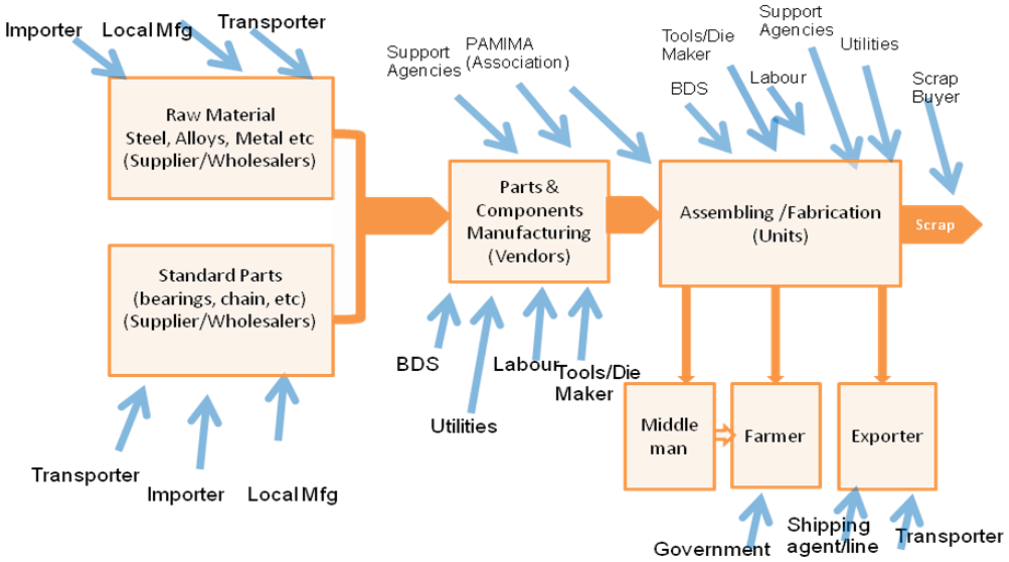
2.4.4 Tools / pattern / die makers

It is a very specialized job and requires extensive practical experience of pressing and forging. Usually tools and die makers have limited knowledge about latest tools and alloy steel or methods of their heat treatment. These tools/patterns/dies are used for manufacturing implements at a large scale.

In view of its importance, Punjab Small Industries Corporation (PSIC) and Technology Up-gradation and Skills Development Company (TUSDEC) – both government entities, have established specialized common facility center with state of the art machinery, in various hubs of light engineering, to provide services of die/pattern making.

2.5 Various Actors of Value Chain of Agriculture Implements Sector:

Figure 2 Major Actors Of This Sector



The role of some of the important players in value chain has been described as under.

2.5.1 Raw material supplier

Steel is the major material being used in agriculture implements, in the form of steel rods, sheets, angles etc. In addition to steel, many other alloys are also used. These suppliers are working in each cluster as well as in major cities. Pakistan Steel Mills Karachi is the biggest

supplier of steel whereas Peoples Steel Mills Karachi is the biggest supplier of various types of alloys. Peoples Steel Mills Karachi does not accept orders less than 20 tons for any particular alloy, which is one of the biggest impediments being faced by assemblers / manufacturers / vendors in procuring any specialized alloy in limited quantity. Alternatively, they buy from scrape houses, which get all types of scrape from developed countries. In such a case, neither buyer, nor seller knows precisely the exact characteristics of metal / alloy.

2.5.2 Provincial Government Agriculture Departments

Departments are working as market promoters by providing subsidy on certain implements. Agriculture departments try to promote certain cultural practices and mechanization as a part of its larger agriculture policy and in turn they provide subsidy to farmers. The amount of subsidy is directly paid to manufacturers, selected under a competitive process, and not farmers.

2.5.3 PAMIMA

Pakistan Agriculture Machinery and Implements Manufacturing Association is the only representative national body of this cluster. The association doesn't have any base station and office, and usually shifts from one city to the other, in line with location of association president. The local units of PAMIMA are also functional in each major cluster.

2.5.4 Business Development Services Providers (BDSP)

Formal business development service providers don't exist except in taxation or accounting related matters. Usually for technical and engineering related issues, manufacturers contact government organizations such as AMRI, FMI, Directorate General of Machinery and University of Agriculture Faisalabad.

2.5.5 Exporters

According to the information collected from manufacturing units and Agriculture Department there are about 20 exporters of Pakistan, who are exporting agricultural implements to regional countries and African countries regularly.

Exporters neither have any structured marketing system nor have their own manufacturing facilities. Exporters usually visit various countries and get orders and then they get their orders manufactured from the manufacturing units of their own choice.

2.6 Export of Agricultural Implements

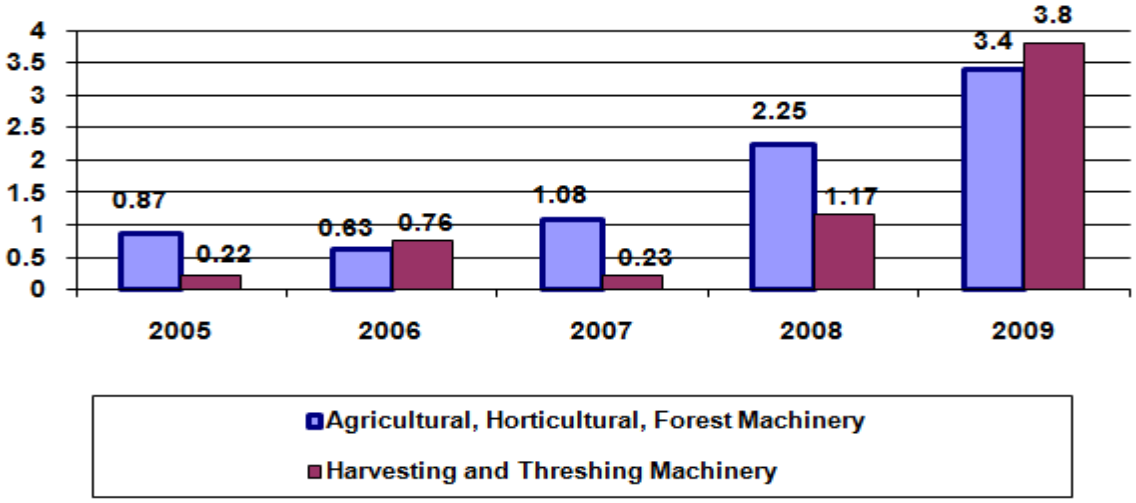
The world trade market of agricultural implements is over US$ 4 billion. Most of this market is for high end standardized products. But due to affordability issues in poor agricultural countries, a market for low end products also exists. According to some estimates, the world trade market for low end products is around US$ 500 million.

Pakistan is also exporting farm machinery and agricultural implements to some neighboring countries as well as third world countries of Africa. In the export market, Pakistan is operating in the lower price segment. Pakistan exported worth of US $ 7.5 million to Afghanistan, Sri Lanka, Bangladesh, Nigeria, Sudan, and other countries in 2009. India, China and Turkey are the major competitors in the markets where Pakistan is operating. The list of existing as well as potential importing countries has been provided in Appendix 2.

Pakistan exports farm machinery and implements to quite a large number of African countries including Nigeria, Kenya, Tanzania, South Africa, Morocco, Ghana and regional countries including Bangladesh, Afghanistan and UAE etc. All of this export is made through export businesses which work as consolidators. Pakistan has a lot of potential to increase this export. This improvement is possible through capitalizing on existing strengths and by overcoming the weaknesses of units as well as the sector.

Some engineering companies or trading companies are also involved in export of parts used in agricultural implements, and usually these are exported to European companies. Exporters usually get such parts manufactured from vendors of automobile sector to meet high precision requirements.[3]

Figure 3 Pakistan's exports of farm implements during the last 5 years



The export of agricultural implements is not stable, because these products are not being sold as branded products. Moreover, manufacturers are not exporting directly. Exporters get the orders from foreign countries and get the implements manufactured from various manufacturers.
Due to this export mechanism, implements manufacturers are not reaping the benefits of current export. If their direct export channels are established, they would definitely improve their product and process.

2.7 Support Agencies

The numerous government, semi-government and autonomous support agencies are working in Pakistan, to provide technical, engineering, and management support to agricultural implements manufacturing sector as well its vendors. These agencies can be broadly categorized into:

2.7.1 Agricultural implements specific agencies / centers

a) In Mian Channu (District Khanewal) a "Center for Agriculture Machinery Industries" was established with financial assistance of Dutch Government (now working as common

[3] http://dartways.com/sectors/12

facility center and training institute and offering 6 months training programs in welding and machining)

b) Farm Machinery Institute Islamabad (under Pakistan Agriculture Research Council)

c) Agriculture Machinery Research Institute Multan

d) Agriculture Mechanization Research Cell (Tando Jam Sindh)

e) PCSIR Center Daska, offering short courses and three years diploma

2.7.2 General agencies

There are certain organizations which provide various services and assistance to agricultural implements manufacturing units directly or indirectly.

a) Engineering Development Board (EDB)

b) TUSDEC (for CAD/CAM designing, Dies and Mould)

c) PITAC (Pakistan Industrial Technical Assistance Center) – Ministry of Industries

d) SMEDA (Small and Medium Enterprise Development Authority)

e) Punjab Small Industries Corporation (PSIC)

3. Sectoral SWOT Analysis

Like any other sector, agricultural implements manufacturing sector has certain strengths as well as weaknesses. Furthermore, there are numerous opportunities and threats, which are required to be taken into account to initiate any sector development interventions in this sector.

3.1 Strengths:

- ✓ Meeting the demand of such a large domestic market
- ✓ Labor intensive and not high-tech
- ✓ Medium investment and machinery with low accuracy
- ✓ Requirement of semi skilled workers
- ✓ Main components tynes, springs, and harrow discs are locally available
- ✓ Ability to develop (copy) the new products as per customer requirements
- ✓ Due to similar manufacturing process, many implements can be manufactured from the same machines
- ✓ Stable demand / business, therefore a good scope of improvement for future

3.2 Weakness

- ✓ Sale is mainly directly connected to the sale of new tractors in the country
- ✓ Implements have a normally long shelf life, therefore replacement sales hardly to the tune of 10 to 15%
- ✓ Cut throat competition on price at the expense of quality
- ✓ Non-existence of quality control systems and standards (at each stage)
- ✓ Problems with quality, aesthetics and finishing (consistency)
- ✓ Weak presence of BDSP's
- ✓ Traditional method(s) of production
- ✓ Non-professional approach of management
- ✓ Poor skill development facilities
- ✓ Poor design and marketing methods
- ✓ Weak financial strength
- ✓ Electricity shortage
- ✓ Lack of knowledge of export marketing
- ✓ No effective agencies to help in export market

3.3 Opportunity

- ✓ Being a low-tech product, it is not of much interest to developed countries for export
- ✓ Possibility of export to regional countries like Nepal, Afghanistan, Sri Lanka and countries of Africa
- ✓ Progressive and innovative enterprises have the ability to grow and meet requirement of export market (low end)
- ✓ Enterprises can join hands together for international marketing, brand building, and participation in trade fairs
- ✓ Unemployed youth can be trained easily
- ✓ Lot of scope for technology up gradation by technological awareness

- ✓ AMRI, PARC, CAMI and Universities can be potential partners to provide opportunities in design, technology, and process improvement
- ✓ Sector is getting attention of some big players
- ✓ Vending base is established

3.4 Threats

- ✓ Oversees importer usually change their sourcing country
- ✓ ISO-9001 QMS are necessary to adopt to enter the high end segment
- ✓ Price escalation of steel, electricity and other inputs
- ✓ Poor law and order situation
- ✓ Skill base needs up-gradation to adopt new techniques
- ✓ Cost effectiveness is essential along with modernization
- ✓ Innovation required in every facet of business operation
- ✓ Advent of newer methods and technology of farming demand changes
- ✓ Changing business environment of Pakistan

4. Constraints to the Growth of the Sector

At present, the sector is facing many constraints which are limiting its growth. These constraints can be categorized into two broader categories:

4.1 Unit Specific Constraints

There are certain constraints, which are unit specific and can be improved if management takes decision in right direction with clear business strategy:

- ✓ Poor skill level of workforce / Poor labor productivity / De-motivated labor
- ✓ Poor management and planning / unawareness of the modern management practices & approaches / good manufacturing practices
- ✓ Management is not visionary to foresee future challenges / forthcoming competition from China and India
- ✓ Usage of obsolete and primitive technology
- ✓ Poor productivity due to high rejection rate, rework and wastage

4.2 Sector Specific Constraints

These are constraints which are applicable to the entire sector irrespective of the management practices of individual units. Some major constraints are given below:

- ✓ Raw material availability problem: the material / alloy / metal with required grade and characteristics are sometimes not available. There are wide variations of quality and material even of the same source
- ✓ Access to capital: the interest rate of bank are very high and moreover due to heavy borrowing of government from banks, sufficient funds are not available for SMEs
- ✓ Last year, imposition of 16% GST on agricultural implements. Government has recently reduced GST on tractors from 16% to 5% but not applicable to agricultural implements
- ✓ Expensive electricity and heavy load shedding / high petroleum prices for backup generator operation
- ✓ Government has not offered any special package / subsidy to promote the sector
- ✓ Access to new export markets (sector level)
- ✓ Availability of skilled labor (in Daska cluster, this is major constraint)

The mentioned constraints can provide the building blocks for the value chain development strategy. USAID Firms Project can design and initiate the interventions on any one or all of these constraints in holistic manner. In the subsequent sections, efforts have been made to discuss each of them in detail along with underlying causes, effects and remedial measures.

5. Production and Operations

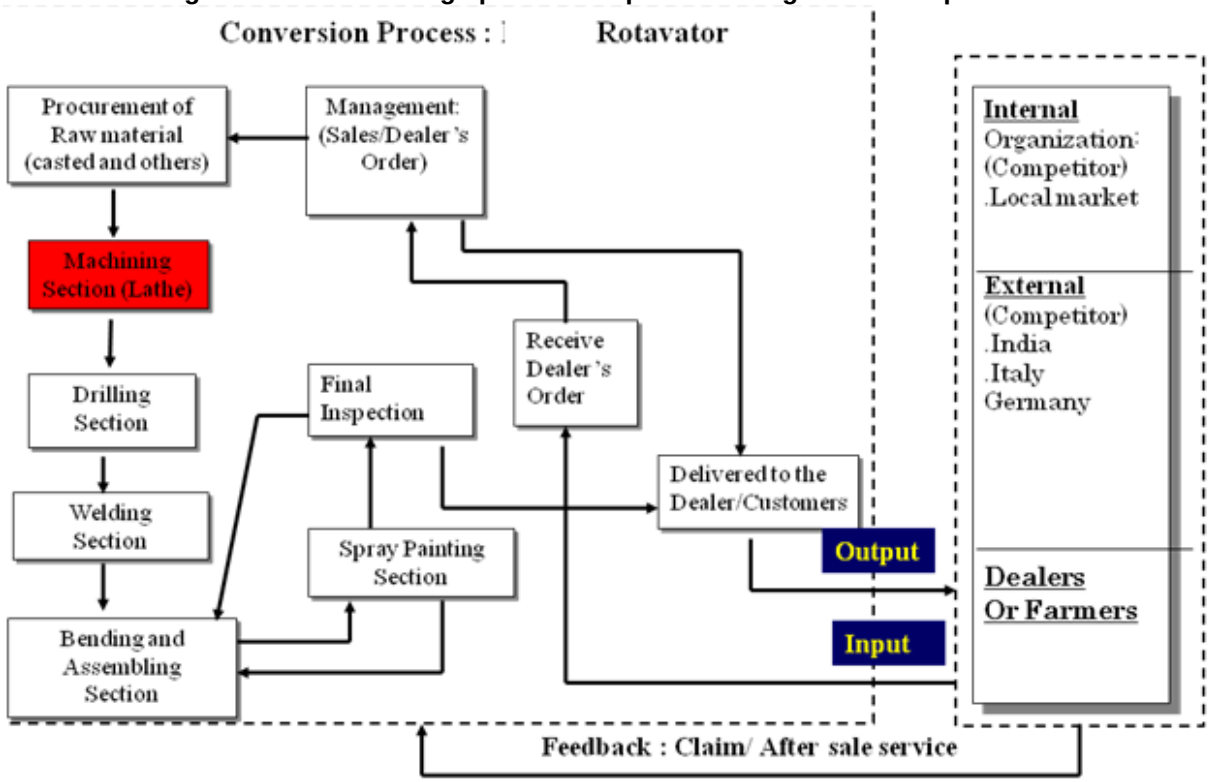
In Pakistan, implements manufacturers have a wide range of products, with different types of mechanical configurations, to meet the different usage and purpose. Cultivators have no moving part whereas reapers and thrashers have high speed moving parts. Likewise, rotavator has gear system. Due to such diversity, no generic manufacturing sequence prevails for the manufacturing of the various products. But even then, some commonalties and differences in the manufacturing process can be identified.
Some of the important operations involved for most of the agriculture implements are;

- Shearing
- Gas Cutting
- Welding
- Heat Treatment
- Assembling
- Cutting
- Punching
- Turning / Machining
- Forging
- Drilling
- Pressing
- Grinding
- Painting
- Casting
- Sheet metal fabrication

For the better understanding of the reader, the operations involved in manufacturing "Rotavator" – one of the extensively used agricultural implements are given below:

5.1 Manufacturing Process of Rotavator:

Figure 4 manufacturing / production process of agriculture implements



The manufacturing / production process of agriculture implements does not involve highly technical operations. Simple machines such as welding sets, power press, lathes, power hacksaw, drilling machines are commonly used. However, some degree of specialization is required in the manufacturing of components like harrow disc, cultivator tyne and cultivator spring / cultivator shovel. Majority of agricultural implements manufacturers usually outsource such parts from other suppliers / vendors.

There is a lot of scope for improvement in the production methods, techniques, and workmanship of implements, but there is even greater room for the improvement in the manufacturing of specialized components.

6. Major Issues in Production and Operations

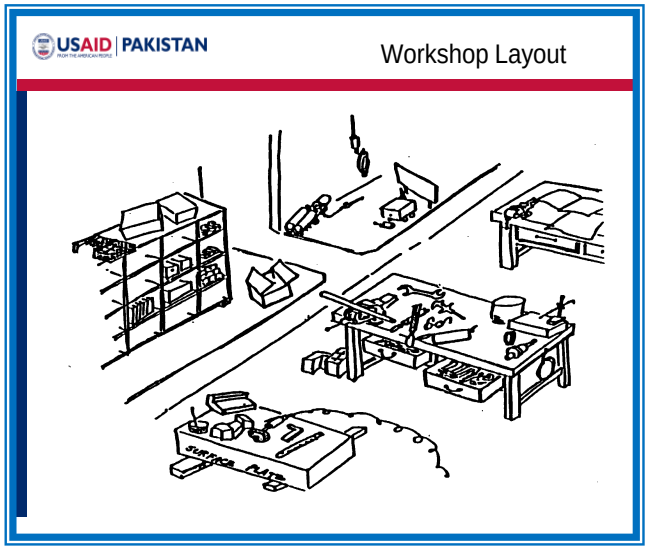
Agricultural implements manufacturing units are currently facing numerous issues that are hampering its growth, profitability, productivity and its cost competitiveness.

The consultant along with USAID Firms Project team members visited Faisalabad, Daska and Okara in January 2012– February 2012 and visited several units. Their production and manufacturing processes were closely observed along with meetings and discussions with top management, supervisory staff and workers. Moreover, information about various segments of the value chain was gotten from Firms Project staff, which already had many meetings with various stakeholders of the sector. Furthermore, the discussions were made with the manufacturers, academia, and executives of Punjab Small Industries Corporation, at awareness seminars, held in March in Daska and Faisalabad by Firms Project. On the basis of all these, some generalized deficient and weak areas of the manufacturing units have been identified, which have been given below along with underlying causes and strategies to improve them. If these areas are improved, the units can improve their cost competitiveness by more than 30%.

6.1 Workshop Layout

Units have poor layouts wherein non-value added activities are excessive. The semi-finished material is difficult to transfer from one operation to the other. It was also observed that during the assembly process, workers have to put extra effort and time to gather Work in Process (WIP) inventory which is spread all over the workplace due to poor layout.

Figure 5: Workshop Layout



An efficient workshop layout can reduce unnecessary material handling, helps to keep costs low, and maintain product flow through the facility. It was observed during the assessment that most of the units have inefficient process layouts which results in time wastage, especially when material moves from one part to another.. The moving time of raw material / in-process parts and searching time for tools increase overall processing and cycle time required to produce the product. This contributes to wa sted working hours and extra wages.

Most of the agricultural implements manufacturer produces customized, low-volume products that may involve different processing requirements and sequence of operations. Implement manufacturers, by improving process layouts, can easily minimize transportation cost, distance, or time which will enhance productivity and quality of the product.

It was also noticed due to inefficient process layout that most of the equipment was underutilized. All units were on batch processing therefore the work in process inventory cost is

also high. As these units have lower volumes, as a result per unit cost is increased. It is therefore necessary to design an efficient process layout so that the manufacturer may enhance productivity and in turn profitability. Due to inefficient layouts the machine setup is more frequent which results in higher setup cost which results in overtime cost. Production scheduling is also difficult with this type of arrangement because the level and type of work is highly variable. This results in large amounts of work-in-process, long product lead times, and high levels of management interaction and engagement. Typically there is a high degree of product movement required by the long and variable routes of individual products through the system. The costs for setting up machines to produce the various products will be high because of the variety of different products and small lot sizes.

The underlying reason of the haphazard layout is their gradual but unsystematic facility expansion. Most of the manufacturing units grew from the scale of black smith shops or small workshops, so their growth and expansions were not well planned and structured. Moreover, the owners and management of these units are not well qualified and educated, so almost all of them are unaware of the modern industrial engineering and manufacturing techniques and practices.

Sometimes, competition forces the companies to upgrade their systems and technology, and to improve their productivity and cost competitiveness, but this is not applicable here because almost all of the units are of the same equilibrium level, and they don't consider moving to higher equilibrium level to meet any local competition. They are earning reasonably good profits by their operations and they didn't feel any need of up-grading themselves in the past.

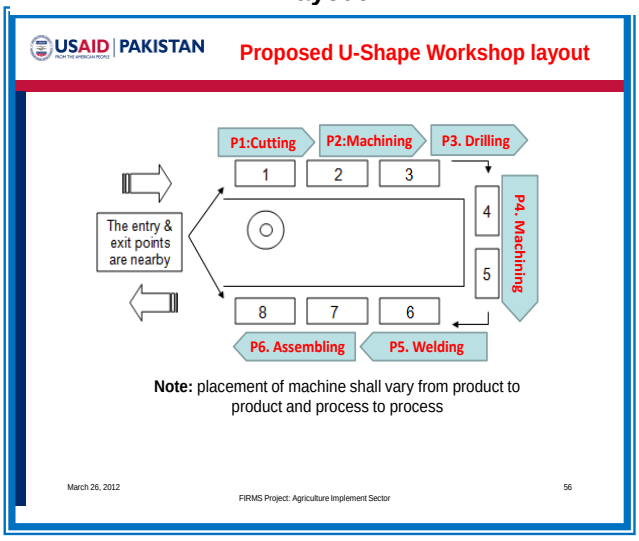
Implements are somewhat heavier and large items require greater transportation cost, so Chinese implements could not evolve as a potential threat for the local manufacturers. But Government of Pakistan's recent move to open free trade with India can be a potential threat for this sector, which can only be tackled with improvement in productivity and manufacturing systems improvement. Many of them are now sensitized to bring about necessary changes to improve their operations.

It was also observed that the management and workers lack knowledge regarding Industrial Engineering (IE) principles. To improve the labor productivity in line with IE principles, management and workers have not undergone any formal or informal training.

Regarding the workshop layout, the proposed improvement practices for the units are given below:

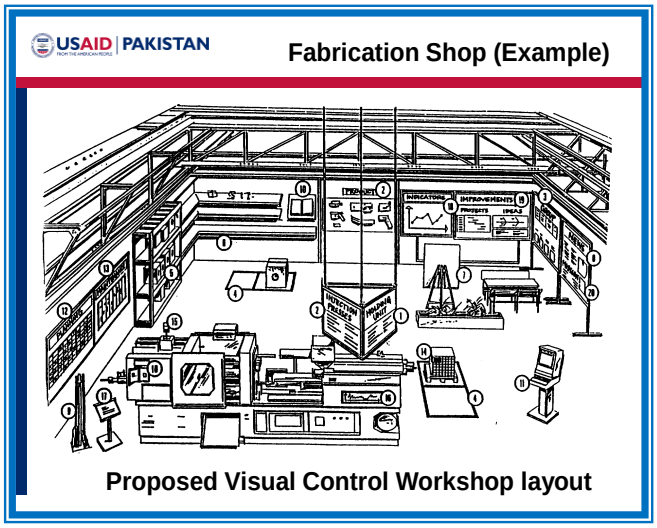
- Preference to the U-shape layout rather than haphazard layout.
- Segregate large and small parts to be welded into separate bays.
- Arrange final fabrication area in a way that material enter form one side and after fabrication, leave from the other side as a finished product.

Figure 6: Proposed U-shaped Workshop Layout



- Arrange workshop so that fabrication activities are carried out in a logical manner.
- Avoid double or multiple handling of products. All work should be done on working table and avoid lifting material from the floor surface.
- Implementation of travel card/KANBAN for all the components to be fabricated so progress can be tracked.
- Arrange lathe and welding equipment maintenance and servicing outside regular hours.
- Arrange the work so it is presented for welding in an ergonomically friendly manner.
- In layout ensure welder(s) can weld with a comfortable posture (avoiding potential back aches). Set work on adjustable trestles so the welder can access the joint easily.
- Outside of the welding plume – avoid situations where welder has to bend over into welding fume.
- Use natural ventilation where possible.
- Perform prototype testing – ensure first off receives full inspection, dimensional checking and non-destructive testing before continuing with remainder of production.

Figure 7: Fabrication Shop, Example



6.2 Workers Skills Upgrade

To increase the overall productivity of the units as well as quality of products and to trigger any technological advancement in the agricultural manufacturing sector, skill up-gradation of the workers would be a pre-requisite.

Each manufacturing unit performs many operations to manufacture an implement. In terms of frequency of operations, importance and time consumption, the following three operations are at the top of the list.

- Electric Welding
- Machining
- Fabrication

In most of the units, these three operations constitute more than 80% of their manufacturing activities. It was also identified that in these critical operations, workers performance is not satisfactory - they are lagging far behind the international benchmarks.

For workers skills up-gradation, the detailed training need assessment is required which encompasses the tasks performed by the workers, knowledge requirement (includes facts or procedures, for example chemical and metallurgical properties of steel), skills (indicates competency in performing a task including hard core skills) and abilities (physical and mental capacities to perform a tasks/operations) required to complete the job. Moreover, the conditions, under which operations / tasks are being performed must be taken into account, because environment and equipment that the employees work in (e.g. work in extremely hot conditions, safety considerations, or performance standards) is highly important.

It was evident during this capacity need assessment study, that most of the workers require hard core skills as well as soft skills for improving their workmanship and productivity.

The majority of workers working in this sector are not trained under some structured skills development programs. They acquire skills and knowledge through master craftsmen under on-job "Ustad Shagird" arrangement. Under this type of skills development, wrong practices are transferred from "Ustad" to "Shagird". Furthermore, most of the time, the supervisor is not willing to transfer the skills and knowledge to the workers to retain his bargaining power at the work place. In this mechanism, workers learn through hit & trial method from their own mistakes which results into poor quality of work and higher wastage and re-work rate.

We observed that many welders prepare thick joints, considering it relatively stronger, whereas, in reality, thick joints leave more cavities inside, rendering it weak. Furthermore, this wrong practice requires depositing more material, more energy, more workers time, and more welding rods. All this is happening due to sheer ignorance and lack of skills, which can be overcome by imparting proper training.

Skills development enhances the efficiency and flexibility of the labor market, reduces skills bottlenecks, and enhances mobility and productivity of labor force. Pakistan is a growing economy with a rising demand for skilled workers. There is acute shortage of trained labor force in the light engineering sector. It is the need of the hour to upgrade and improve quality of technical and vocational training institutions and introduce on job multi-skilling courses whereby worker can upgrade his technical skills and imbibe relevant knowledge and learn concepts and tools related to productivity and quality. We interviewed workers in selected clusters and observed that only a few workers are diploma holders from various vocational institutions. But the irony is that they have good theoretical knowledge but are very weak in practical skills because they were not exposed to practical skills exhaustively during their training courses.

Key constraints to improve the quality of vocational training include curriculum, which is not responsive to market / industry need, non availability of competent technical trainers, absence of proper feedback system from industry, lack of financial resources, very rigid training model, and mismanagement of technical institutions and their supervisory bodies.

It is also recommended that the vocational training institutes must introduce internationally recognized professional certification programs like, certified lathe operator, certified welder, certified driller, certified fabricator, certified fitter etc. The main purpose would be to develop critical mass in Pakistan so that labor shortfall can be reduced. The Daska cluster has acute shortage of skilled workforce and manufacturing units are facing the severe problem of availability of workers. The bargaining power of workers has risen to such a level, that employer has to give advance salary to hundreds of thousands of rupees to retain their workers. Such situation can be improved only if formal training system can produce workers equipped with right kind of skills, knowledge and personality attributes.

For the existing employees of the manufacturing units, who can't spare time for any full time training out of the facility or even on-facility, due to losing of wage, some alternative model is required. It becomes essential because owners of these units are not willing to send their workers outside of their facility for training purpose during normal working hours, to avoid any production loss. Moreover, mobility of employees within the sector and across sectors is high, which restricts owners to invest on workers up-gradation in terms of money or sacrificed time.

One viable alternative model of training could be on-job training of workers, where they can gain knowledge, learns new concepts as well as technical expertise / skills at their work place, during their paid time.

The model can be developed, where a full time trainer – specialist of a particular trade (such as welding, machining, fabrication etc) is attached to 2-3 units for three months where he/she spends the whole day with the workers and provide on-job guidance and training. Multiple trainers of each specialized trade can be deployed on a revolving basis.

6.3 Inefficient Energy Usage

During the assessment it was noticed that almost all of the units have never done any energy audit, and are not sensitized about energy related issues. Manufacturing units are not using best practices of energy efficiency which increases per unit cost of production.

It was evident during the assessment that none of the implement manufacturers were using energy efficient welding plants. The energy consumed during standby period is around 9-12 Amps and during welding process most of the welding sets consume 35-40 amps. Normally these welding plants are kept continuously on, even though the welding operations are not carried out. During idle time the welding transformer draws the magnetizing current or no load current which is not doing any useful work. Some of the reasons of idle time are inefficient workshop design, delays in work-in-process inventory, poor material handling and transportation system (within the facility).

Energy has become a major issue of these manufacturing units. Not only electricity tariff has been doubled in the last four years, but also severe announced and unannounced load shedding has become order of the day. To cope with the load shedding, units have to operate their own diesel generators which further jack up their cost; due to high oil prices in Pakistan.

The energy inefficiency is related to the following three main reasons:

1. Technology being used is inefficient

2. Due to poor technical skills and poor knowledge about the operations /processes, workers uses machines / equipment for more time, that result into more man-hours, more energy cost, and more machine/equipment wear and tear.

3. Employees / workers are not sensitized about energy conservation and are not well aware of the energy saving techniques. They are not trained to adopt best practices of energy management which can help manufacturers to become cost effective.

For better energy efficiency, the following measures are required:

- ✓ Energy audit should be undertaken to identify weak areas related to energy loses. This audit will help in identifying energy conservation initiatives required for every unit which will have direct impact on cost of production.

- ✓ Replacement of machines / equipment: Particularly arc welding plants transformers being used are of very obsolete technology and their replacement is essential. At present, if we analyze energy consumption of each machine and equipment, installed in any agricultural manufacturing unit, the arc welding plant are the most frequently used equipment in any unit, in terms of time and number of equipment.

  It is therefore, recommended to use DC welding set instead of AC or Electronic sensing unit can be installed with the existing AC welding plant which will detect the non-weld periods and switches off the power to the welding transformer, hence will save power during idle time. When welding operation is to be restarted, the operator just needs to touch the electrode with the material to be welded and the unit instantly starts the weld which then can be carried on continuously.

  Proposed welding plant is not very expensive, and if we calculate its cost-benefit analysis, a new proposed plant can recover its capital cost with only 700 hours of usage through energy saving.

  Similar to energy efficient welding plant installations, the latest lathe machine (CNC) operation is very critical and important. During the assessment, in the current manual lathe machine setup time has been very high especially during the work in process inventory transportation from one process to another. The CNC machine operator only needs basic training and skills, enough to supervise several machines. Fewer workers are required to operate CNC machines compared to manually operated machines. CNC machines are programmed with a design which can then be manufactured hundreds or even thousands of times. Each manufactured product will be exactly the same. There is one disadvantage in technological up-gradation i.e. the investment in CNC machines can lead to unemployment.

  It is therefore recommended that the manual lathe machines may be replaced with the high energy efficient auto lathe machines which can increase the product quality as well as precision and accuracy in the product will be maintained.

- ✓ The welding process is a labor intensive technology, especially in the small fabrication shops. Electrodes, equipment depreciation and fluxes constitute a very small portion of the overall welding cost. The same is the case of lathe / machining work. Therefore, the prime focus of cost reduction may be controlling electricity losses as well as reducing the amount of time required for operation(s).

- ✓ Existing bulbs and tube lights are to be replaced with energy savers or LED lights.

- ✓ Employees are sensitized and their capacity is developed by training for energy saving techniques.

6.4 Labor and Operations Productivity

Labor productivity depends upon the following major factors:

1. Skill level of workers
2. Work environment in terms of work stations ergonomics, tasks / sub-tasks he has to perform (including non-productive and unnecessary tasks) to complete
3. Work shop layout and product/material process flow system (assembly line, batch system etc)
4. Motivation of employee**(s)**

It was identified during the assessment that most of the agriculture implements units in Faisalabad, Deska, and Okara are family – owned. Most of the skills have been acquired through elders under informal system of learning. Therefore, the overall vision for expansion and growth is lacking along with technical and engineering expertise.

It was also observed that units are offering low remunerative packages for the workers, hence unable to attract and retain qualified workers. As a result, low wages has resulted in low productivity, which increases cost which further forces the manufacturer to hire cheap labor. In this way, manufacturing units have become the victim of vicious circle of:

6.4.1 Low Wages – Low Productivity – Higher Manufacturing Cost – Further Reduction in Wages

The owners and management have the wrong belief that if they pay more to their workers, they would be at disadvantage by getting less profit, because high payroll increase their production cost. But "Efficiency Wage Theory"[4] says that giving above market wages actually increases the profit rather than decreasing owing to better labor productivity, low employees turnover and low employees hiring cost.

Due to faulty workshop layout and material process flow, a lot of non value added activities are undertaken in manufacturing units. The labor productivity of the workforce decreases due to such non value added activities at the workplace. It is therefore recommended that in order to enhance labor productivity of an agricultural implements manufacturer, it is necessary to design ***Intelligent Operational Layout*** in which welders / machinists / fabricators need to remain in their operational areas and focus on their respective operations. These operators / workers need to be provided with specific work instructions, based on the drawings, to avoid time wastage in chasing drawings, procedures, parts or consumables. These activities need to be the responsibility of non skilled workers (helpers/daily wagers) whose job function and focus should be solely on maintaining material flow between work areas so that welders, machinists, fabricators and assemblers focus on their core expertise and maintain their *Takt Time* (maximum time per unit allowed to produce a product in order to meet demand). It was observed in all the units that skilled workers were performing helpers' tasks rather than value adding jobs.

Machine downtime due to multiple causes is another big issue. Most of the workers are unaware of the actual losses being incurred on production that can be saved if proper material handling and machinery is maintained. The crude psyche of the human resource can be gauged from the fact that no preventive measures are usually taken to avoid machine downtime.

[4] *Presented by a professor of Stanford University*

In order to enhance worker's efficiency, assembly station can also operate on a cart system. The fitter can be provided with the specific components, consumables and tools for the part/machine he is working on, as well as, that for the next one. When a cart is emptied, that signals the helper to bring the next consecutive one. This way, material traceability established at receiving is maintained through the process. This help reduces the time lost in item tracing and /or re-ordering. Likewise, set-up time can be reduced. Such initiative could conceivably reduce man-hours by 40%.

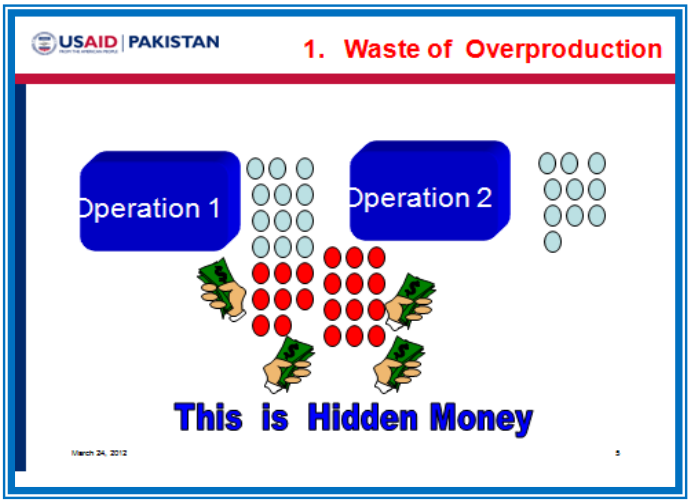
In certain worst case scenarios, these non value added activities comprise of 95% of the total operation whereby only 5% are value added activities. In line with Japanese philosophy these non-value added activities are called "**MUDA"** which means **"Wastages"**. They are:

i. Waste of Overproduction
ii. Excess inventory
iii. Defects or Rework
iv. Over processing
v. Waiting time losses
vi. Underutilized people
vii. Excess Worker motion
viii. Waste of Transportation

If agricultural implements manufacturing units can understand the abovementioned wastage, and can rectify their systems to remove them, labor productivity and overall system productivity can be enhanced manifold. The major underlying cause of all these wastage is lack of management skills of top management of the manufacturing units.

6.4.2 Waste overproduction

Figure 8: Waste Overproduction



Waste overproduction was observed during the assessment. Most of the units are using push production system because of seasonal demand of agriculture implements therefore in each operation a lot of work in process inventory has been identified.

It was evident that due to excessive semi finished material on the shop floor, most of the operators are busy in the placement or storage of those semi finished products rather than utilizing the technical skills for value added activities.

Some symptoms of overproduction observed during the live assessment:

- Excessive raw materials
- Extra inventory
- Unnecessary work

- Excessive floor space utilized
- Unbalanced material flow
- Complex information management
- Extra waste handling & treatment
- High utility costs

Some root causes of overproduction are labor absenteeism, long operations / process set-up, unleveled scheduling, unbalanced workload, seasonality, over engineered equipment/capability and redundant inspections.

The consultant is of the view that manufacturer should not produce more than next process demand and should introduce system to build confidence in each operation /process, to reduce machine set-up times, to improve machine condition, to improve worker motivation and attendance, to introduce multi-skilling and to develop multi-tasking attitude of worker. The indirect ways of reducing over-production is by reducing finished goods area, reduce space between two operations and implementation of Super 5 S Japanese housekeeping standards.

6.4.3 Excessive Inventory

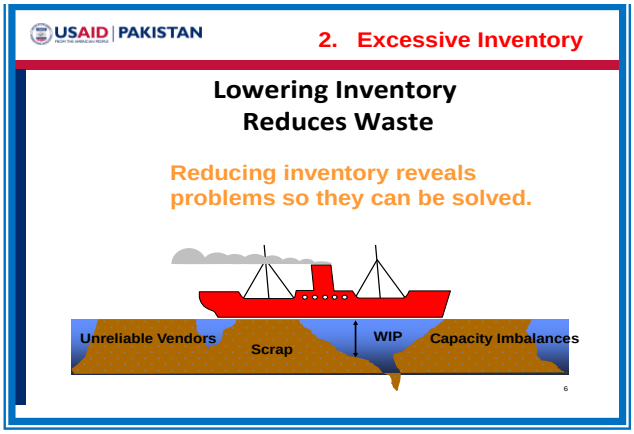
Figure 9: Work in progress Inventory

Excessive inventory is also common in agricultural implements manufacturing units. This is not just of supplies and materials but also other resources which are not being utilized properly. These resources include equipment that remain idle or rest in storage. The same is the case with employees that have skills and spare time, which are not being used to their fullest.
High Work in Progress (WIP) inventory is a direct result of *overproduction* and *waiting*. Excess inventory tends to hide problems on the shop floor, which must be identified and resolved in order to improve the operating performance. Due to excess inventory in the units, lead times of procurement / production of any item are also increased. It also consumes productive floor space, delays the identification of problems, and inhibits communication. By achieving a seamless flow between work centers, implement manufacturers may improve customer service and slash inventories and their associated costs.

Some symptoms of excessive inventory are:

- No tracking system of finished goods, work in process inventory and raw material
- Extra storage and handling
- Extra rework/hidden problems
- Stagnated information & material flow
- High disposal costs
- Obsolete material/land fill

Figure 10: Excessive Inventory

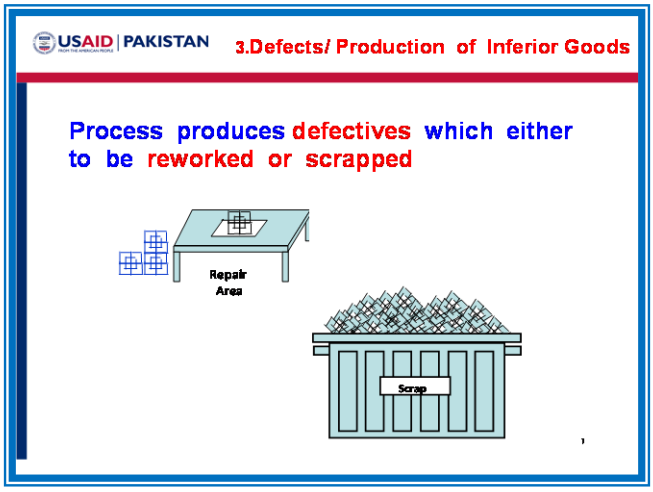


Some possible root causes of excessive inventory are product complexity, incapable processes, unleveled scheduling, poor market forecast, unbalanced work force, and unreliable supplier shipment.

It was also observed in the visited units, that the lot size during each operation is very high therefore WIP inventory is high. This inventory can be reduced by small lot size. But to implement this, manufacturers have to ensure proper working of their machines/equipments through proper preventive maintenance.

6.4.4 Defects & Rework

Figure 11: Defects/Production of Inferior Goods



It was also observed that most of the manufacturers are using low quality casted material where defects are exposed after executing one or two operations by the operators. Once defects are exposed, the part is discarded but it consumes unnecessary operator and machine's time as well as energy. This kind of scrapping has a direct impact to the cost to the organizations. Other associated costs include quarantining inventory, re-inspecting, rescheduling, and capacity loss. In most of the agricultural implements manufacturing, the total cost of defects and scrap is often a significant percentage of total manufacturing cost. Reworking is also very common to rectify the problems, caused by operator's negligence or operator's poor skills or due to poor quality of material.
Some symptoms of defects & rework are:

- Rework, repairs & Scraps
- Added inventory costs
- Customers returns

- Loss of customer confidence
- Missed deliveries
- Hazardous waste generation
- Frequent spill cleanups
- High disposal costs
- High quality cost

Some root causes of defects or rework are weak process control, questionable quality, lack of error proofing, unbalanced inventory level, deficient planned maintenance, poor product design, poor quality of raw material used, customer misunderstood needs, improper handling, poorly managed waste streams and inadequate training.

The consultant believes that the number of defects or rework can be reduced once the manufacturer follows standardized manufacturing process by adopting proper product design and by using proper pattern / dies to manufacture various parts. Besides this, the manufacturer should purchase quality raw material / parts. It will be pertinent to mention that defects rate in cast parts, coming from vendors, are comparatively less in Okara clusters. It was observed that in Okara, the defect rate is about 5% whereas in Faisalabad and Daska cluster, this rate is between 20-25%. This defect rate is only of cast part and if we cumulatively add the defects of all parts procured from vendors and raw material purchased from suppliers, the defect rate is even greater.

6.4.5 Overprocessing

Overprocessing is another waste observed during the assessment especially when machine operator puts extra effort (non value added activities) on a semi finished product. It was also noticed that in many cases, the distance from one operation to the other is unnecessarily greater due to poor workshop layout; therefore subsequent operations are located far apart. The consultant observed a number of non value added activities in the fabrication process where extra efforts are being put in by the workers to perform the task. The major reason is that operators are not clear what exactly needs to be done in a particular operation.

Waste in operation can be reduced by “defining clearly work done by machines and work performed by operators”. If machines have a timer or auto function or predetermined time setting, then workers can handle multiple machines simultaneously.

6.4.6 Waiting Time Loss

Waiting time loss is also very common in agricultural manufacturing units, especially at the fabrication stage. In these units, traditional batch-and-queue manufacturing process is being followed. It was also observed that most of a product’s lead time is tied up in waiting for the next operation; this is usually because material flow is poor, production runs are too long, and distances between work centers are too large.

It is therefore recommended to link processes together so that one feeds directly into the next. This can dramatically reduce waiting. Waiting time loss also occurs due to longer setup times of the machine therefore time management can really help manufacturer in reducing lead time.

6.4.7 Underutilization of Workers

Figure 12: Under-utilized Workers

The time of skilled workers is not effectively utilized, and they waste a significant part of their precious time for shifting and storing products from one place to another. Some of them even waste time in picking most of the semi finished work in process inventory from the floor and transferring it to next operations.

Moreover, the workers also waste time in searching various tools owing to nonexistence of proper trolleys or storage boards for tools. By streamlining the operations, reallocation of skilled, semi-skilled and unskilled workers time and by provision of some small boards/ trolleys, the time management of the workers can be improved tremendously.

6.4.8 Excessive Workers Motion

Figure 13: Ergonomics

Workers extra motion (ergonomics) was evident in all the manufacturing units and workers have to bend, stretch, walk, and lift frequently but unnecessarily; to perform the assigned tasks / operations. That is due to poor design of operations / jobs, and this leads to poor labor productivity. It is suggested that jobs with excessive motion should be analyzed and redesigned for improvement.

It was also observed that most of the workers lift heavy metal products such as steel that weighs 20 kg or more and/or longer than 2m, and are moved in the workplace from the raw material storage area, through each production process, and up to the distribution of the final product. The weight of these items is greater and manual handling is difficult and involves risks related to the awkward postures and hitting someone during carrying materials. So excessive motion can be controlled and decreased by redesigning the jobs / operations.

Figure 14: Transportation Waste

6.4.9 Waste of Transportation:

Transporting products between processes is a cost incursion which adds no value to the product. During the assessment, excessive movement and handling which causes damages to the product quality were noticed. Moreover, it wastes a lot of human energy and time without adding any value. For in-house transportation, from one operation to

the other, material handlers such as small carts, wheel mounted platforms, revolving shafts etc., can be developed to facilitate such transportation. Another option is to bring closer the equipment and processes, but this entails significant cost. To get better results, it is equally important to determine the sequence of processes, which requires detailed mapping of product flows.

6.5 Technological Upgrades

To manufacture quality products with competitive cost, the technology, energy efficiency, productivity and accuracy of machines / manufacturing plant / equipment play the most crucial role.

At present, the manufacturing units have the following deficiencies, with respect to manufacturing hardware:

- Technology of machines being used is obsolete. For example they are still using 50 years old welding plants, whereas welding plants based on better technology are available for the last many years. The new technology is capable to provide better quality with less energy. Likewise, almost 100% production is lathe based and CNC machines are not prevalent in this sector, which is now very common for such manufacturing across the globe.

  The latest technological advancement has the capability to fabricate varieties of processes with less wastage, greater productivity, more reliability, functionality and ease of operation and high profitability. The newer versions of the machines also consume less electricity, and have low servicing and maintenance costs.

- Machines / equipment being used in manufacturing units, irrespective of their capability, are not properly calibrated and aligned. During visits of manufacturing units, it was observed that the alignment of most of the lathe machines is out by many millimeters. One can expect the accuracy and standardization of the parts, being manufactured on these machines. In most of the cases these are either due to ignorance or manufacturers are not sensitized about the importance of these aspects of the machines.

Some of the agricultural implements manufacturers are well aware of the new challenges of the global economy and emerging needs of domestic market. They know about the prevailing technologies in the market; however, the decision to up-grade varies from person to person.

Subject to the availability of funds, USAID Firms Project can identify the customized needs of the technology upgrades of the units in order to improve their manufacturing capacity. For such intervention, criteria can be developed by analyzing the production process and then evaluating the frequency, weightage and importance of the various operations and then rank the respective machines / equipment for replacement / improvement.

Punjab Small Industries Corporation is operating common facility centers in Daska, Faisalabad, Multan and Lahore related to light engineering works. Likewise, Technology Up-gradation and Skills Development Company (a semi-government organization working under industries department) is operating its common facility in Gujranwala, close to Daska. All these common facility centers (CFCs) have state of the art machines. It would be a great success, if USAID

Firms Project can create a linkage between manufacturing units and these common facility centers. This would be a win-win situation for both. Implements manufacturing units can get better quality parts, at competitive prices whereas these CFCs, which are currently under utilized, can improve their utilization factor and to attain their reason of existence. The need is to gather all stakeholders sit with them and develop a viable business plan whereby manufacturing units identify the parts, they can get manufactured from these CFCs, and these CFCs can work on economies of scale to produce high quality parts at cheap rates.

6.6 Overdesigned Implements:

One of the key features of the agricultural implements being manufactured in Daska and Faisalabad clusters is the over designed – use of heavy parts and unnecessary usage of steel, far greater than safety factors. These parts are not designed or manufactured keeping in view of stresses and forces or by prior simulation tests. Many manufacturers use the weight of their implements as Unique Selling Point (USP) and many illiterate framers are also obsessed with this and are of the view that heavier the agricultural implements, the better its performance would be. They are not cognizant of the fact that with an over designed agricultural implement; tractor uses excessive fuel with high wear and tear.

Farmers' unawareness is the major issue in this regard, which is to be addressed. An awareness campaign can improve the situation. Advertisement in the agriculture related magazines and talk show on FM can create greater impact with minimum cost.

It is also recommended that USAID Firms Project may facilitate the government institutions like PSQCA, PCSIR to develop product standards and facilitate them ensuring compliance by the implement manufacturers.

6.7 Product and Process Standardization

One of the biggest issues, this sector is currently facing, is the absence of product and process standardization. The finished products are not standardized and identical even within one unit with respect to design, product specifications, material properties and functional performance. Moreover, tolerance level of each part is very high. This problem can be understood by the example that during fabrication stage, if a worker drills over size or undersize hole in some part mistakenly, manufacturer does not reject the part but would use over sized or undersized bolt / fastener there.

Due to all these, end user (farmer) face severe problem, when he/she needs replacement of some faulty parts of agricultural implements, because even manufacturer don't keep the record of specifications of the products and parts fitted therein.

The major underlying reasons of this phenomenon are:

6.7.1 Design Drawings

Agricultural implements manufacturing units are not manufacturing implements in accordance with any detailed product design and material specifications. Moreover, they do not adhere to any standards / quality parameters in true sense. At present, hardly the detailed drawings along with material specifications of any implement are available in Pakistan.

Manufacturers normally copy the imported or local well built implements rather than developing own designs with special feathers. Only few manufacturers do limited efforts to search some new features by using internet or any industrial magazines, to add extra features / functions in the agricultural implements to make it a unique selling point.

In view of the current capacity of management and human resources of these units, they are hardly capable to understand drawings and then to manufacture accordingly. But one of the core strengths of these units is their capacity in reverse engineering. This strength can be further polished and be utilized more effectively if USAID Firm Project could arrange some technical experts to work with the units for manufacturing a few implements according to the engineering drawings and material specifications, under their close supervision. These units can then replicate these implements at commercial scale with precision and quality.

6.7.2 Infrequent Usage of Jigs / Pattern / Mendel / Prototype

The usage of pattern, jigs, mendel, and dies help improve the standardization, especially, if labour force does not have much literacy and skills level. The consultant noticed that with the exception of few, manufacturers don't adhere fully to these standardization tools, which can help reduce rework, rejection, and wastage.

One possibility is that USAID Firms Project select 4-5 implements, in view of their usage / quantity in the country (Annexure 1) and get their drawings prepared from experts. In second stage, the jigs / pattern / mendel / dies be prepared in line with drawings and then to distribute among the manufacturing units. Thirdly, the technical experts get some pieces of these implements manufactured under their close supervision. This is the only mean through which we can initiate standardization in this sector.

6.7.3 Standardization of the production system

For standardization of any manufacturing process, systems need to be in place. Work flow, quality assurance and quality control system must be structured. Moreover, standardized machines and equipment with right calibration are also a prerequisite.

6.8 Certification

ISO 9000 certification is considered the symbol of product and process standardization across the globe and conveys the image of quality product. That is why in Pakistan and in abroad, customers / organizations prefer to have business with ISO 9000 certified firms. For light engineering and agricultural implements manufacturing sector, ISO 9000 is considered the most relevant certification.

At present, in Pakistan, hardly any agricultural implements manufacturing unit has ISO 9000 or any other certification. It is high time that USAID Firms Project provides financial and technical assistance to this sector to attain ISO 9000 certification. This would help the manufacturing units to place systems at their facility, leading to standardized manufacturing processes and products that would help improvement in the quality with less rejection, rework and customer complaints. Because of the certification, manufacturers will have better control on production operations. Certification will also develop proper system for Quality Assurance (QA) and Quality Control (QC) which are missing at this point of time.

ISO9001 certification will not only strengthen internal system of the companies, it will also develop SOPs and work instructions for the operators. This would also open doors for export market due to enhanced credibility of the certified unit.
It would be pertinent to say that sensitization of manufacturer are required where they could take these certification as a means for process and product standardization and quality improvement and not as another feather in their cap, or certification for the sake of certification.

6.9 Lack of Quality Assurance (QA) and Quality Control (QC)

During the assessment it was also observed none of the units were having proper QA/ QC systems in place. No inspection data was available during the live audit i.e. rate of rejection, rate of rework, etc. Even most of the units visited by the consultant do not have any inspection checklist or parameters. The operators have not been provided with the proper drawings or instructions for the product to be manufactured. No quality planning is practiced during the production activities, however only final inspection is done after completion of all the processes which sometimes results into rework. It is therefore recommended that in process inspection to be incorporated along with proper inspection checklist. In order to ensure compliance to the specifications, statistical process control (SPC) tools such as control chart etc. can be introduced in some critical process. It is also suggested to involve QC/QA activities into the daily fabrication activities. Individuals involved with the implementation of quality systems should not be regarded as **"policemen"**. Integrate "hold point" inspection activities into the production activities to ensure production does not stop during inspection – never rely on final inspection of a product to demonstrate compliance.

Technical assistance and hand holding are required to capacitate the manufactures to develop an inspection and test plan that involves quality personnel at all stages of the production as well as for the procurement of materials and specialty products.

6.10 Calibration & Alignment of Equipment / Machines

Calibration and alignment of the equipment / machine are most neglected areas of these manufacturing units. During visits, consultant got the opportunity to observe some lathe machines, whose alignment was several millimetre out, but they were being used for machining process.

In these manufacturing units, measuring devices such as verneir calliper, screw gauge, micrometer etc. are never calibrated, once they are purchased. These instruments are not even handled properly by the workers. It was also noticed that these operators have never been provided formal training for these equipment. As these instruments are not calibrated therefore lot of variation is identified during production / assembly process which are sometimes rectified by rework but many time these go without check, having compromised on standardization.

6.11 Reliable Source of Raw Material

The major raw material used in agriculture implements is mild structural steel (flat angles, channels, squares, pipes, plates of various thickness, sheets etc.). High carbon steel is also used in some products. Steel is one of the major cost elements in the overall cost structure of any implement. Main source of this raw material is through local suppliers situated in Lahore and Gujranwala.

Most of the units showed dissatisfaction about the available quality of steel in terms of specifications, thickness, carbon percentage and other quality parameters. Pakistan Steel Mills was once considered one of the best suppliers of steel but now many units have complaint about the quality and consistency of its steel.

Specialized applications require special alloys, especially where implement has to undergo high pressure or stress or speed or friction or other forces. Therefore, manufacturers have to procure special alloys, which are only available with Peoples Steel Mills Karachi, which does not entertain less than 20 tons order. Usually any manufacturer does not require this much steel at any one point of time, or alternatively he procures and keeps an inventory for years, resulting in blockage of space as well as money. Alternatively, manufacturers try to locate that material or anything close to that from the scrape material, which usually comes from broken ships, destroyed warfare weapons, discarded machinery etc. The availability of these raw materials is the major impediment in the standardization of implements. Every time, manufacturer gets material of different specifications and consequently he goes for different design / performance parameters. The same is the case with some standardized products such as gears.

The management of most of the units are unaware of the characteristics of the material / parts, and many of them who are somewhat aware they are not much sensitized about the importance of the quality and specifications of raw material. Moreover, in the sector, there is no practice of material testing for its physical, chemical or other properties, resulted in wide variation of specifications, characteristics and properties. Furthermore, manufacturing units switch their suppliers/sources of raw material and parts frequently, which inhibits the standardization.

In most of the cases, these manufacturing units buy raw material on credit, which forces them to accept whatever the supplier provides, irrespective of quality. Such lower bargaining power of manufactures vis-a-vis raw material suppliers, under credit arrangement, leads to many non-standardization and quality related problems.

The norm / practice of bulk purchase by a group of manufacturers (pooling) does not exist in the sector. Some years back, SMEDA initiated an idea of “Material Bank” for agricultural implements manufacturing sector to ensure the supply of raw material with exact specifications / quality at right price but unfortunately this idea could not take off. Such idea can solve the problem of material availability but manufacturers’ procurement on credit is the major impediment. To make the material bank model workable, some limited raw-material-specific credit line at some subsidized rate would be required with the banking channel for each manufacturer. Moreover, the initiation and working arrangement of this raw material bank is a great question mark and may require extensive deliberation by major stakeholders.

During this study, many of the manufacturers opined that now situation has improved and currently they are not facing any such problem, because many suppliers in China are now supplying as low as 500 pieces of various finished products, meeting buyers’ customized specifications, with very short lead time.

6.12 Quality Issues of Casting Part

The poor quality of casting parts is one of the major issues, this sector is facing. The percentage of casting parts varies from impalement to implement. In certain implements, more than 40% parts are casted. Such a high ratio of casting parts speaks volumes about the importance of casting in agricultural implements manufacturing sector.

The small specialized casting units, which are meeting more than 90% demand, are still using the primitive methods, based on sand. They are totally unaware of material properties, heating requirements, etc., and resultantly poor quality parts are being cast and sometimes the rejection exceeds 25%. Almost none of them are using dyes to cast part, due to initial higher cost of dyes. If few manufacturers, who are manufacturing similar products, join hands to place bulk orders of cast items, then dyes can easily be used, which would increase the quality of parts significantly.

6.13 Material Lab Testing Facilities

Material testing is a must in all industries, particularly in the manufacturing sector. It was noticed that some of the agriculture implement manufacturer are well aware of the importance of the testing of the raw material / parts but usually they do not go for it, unless some export order or local buyer clearly demands for some particular grade of steel / alloy with particular specifications. However, such testing facilities are not available within the clusters, caused lot of delays and increase in cost. It was identified that institutions like PCSIR, TUSDEC[5], and PITAC etc. have different metal / alloys testing facilities but the solution is not cost effective and manufacturers hardly utilize these services, only in dire need. In routine manufacturing, aimed at general farmers, manufacturers do not go for any material testing and use whatever material / part they get in the market easily.

In order to enhance export of the sector it is imperative to sensitize the manufacturers to go for testing of alloy / metal / parts for quality and standardized products. USAID Firms Project can join hands with PCSIR, TUSDEC, PITAC to develop some mechanism through which manufacturers can get testing facility at reasonable rate with quick response.

6.14 House Keeping Issues

Poor housekeeping is another area which requires attention. None of the implement manufacturer is following housekeeping standards. It was noticed during visits that un-necessary items were stored in the units without solid reasoning. Similarly tools were not organized and the traceability period was very high.

Moreover, cleaning has been one of the serious concerns identified during the assessment. The manufacturing units lack discipline, arrangement and standardization. Machines are not properly cleaned and inspected by the operators. They belief their task is only confined to the operation of the machine and maintenance staff is responsible for their maintenance and cleaning. The employee's ownership for the shop-floor is lacking in all the units visited. Identification and traceability of raw material, semi-finished items or inspected items is also difficult. The presence of unnecessary items in visited units is quite common. Moreover the placement standards are

[5] *TUSDEC has recently established Dies and Tools Center in Gujranwala which is capable of performing various material tests, required by agricultural implements manufacturing sector.*

not well defined. Poor housekeeping can frequently contribute to accidents by hiding hazards that may cause injuries. Poor housekeeping can be a cause of accidents, such as:

- ✓ Tripping over loose objects on floors, stairs and platforms
- ✓ Being hit by falling objects
- ✓ Slipping on uneven surfaces
- ✓ Striking against projecting, poorly stacked items or misplaced material
- ✓ Cutting, puncturing, or tearing the skin of hands or other parts of the body on projecting nails, wire or steel strapping

To avoid these hazards, the workplace must "maintain" order throughout the workday. Although this effort requires a great deal of management and planning, the benefits are many.

Effective housekeeping can eliminate some workplace hazards and help get a job done safely and properly. Housekeeping is not just cleanliness. It includes keeping work areas neat and orderly; maintaining halls and floors free of slip and trip hazards; and removing of waste materials (e.g., scrap, iron pieces) and other fire hazards from work areas. It also requires paying attention to important details such as the layout of the whole workplace, aisle marking, the adequacy of storage facilities, and maintenance. Good housekeeping is also a basic part of accident and fire prevention.

In view of aforesaid factors, it is recommended that manufacturing units must implement productivity tools like Super 5 S Kaizen (Japanese housekeeping standards), which will not only help them improve housekeeping, productivity and product quality but also morale and safety of the employees. After effective implementation of Super 5 S Kaizen, the organizations usually acquire the following benefits:

- ✓ Reduced handling to ease the flow of materials
- ✓ Fewer tripping and slipping accidents in clutter-free and spill-free work areas
- ✓ Decreased fire hazards
- ✓ Lower worker exposures to hazardous substances (e.g. dusts, iron pieces)
- ✓ Better control of tools and materials, including inventory and supplies
- ✓ More efficient equipment cleanup and maintenance
- ✓ Better hygienic conditions leading to improved health
- ✓ More effective use of space
- ✓ Reduced property damage by improving preventive maintenance
- ✓ Improved labor productivity (tools and materials will be easy to find)

6.15 Safety Issues:

Figure 15: Safety Issues

During the visits, the consultant noticed some minor injuries and accidents to employees. It was observed that none of the manufacturers provided Personal Protective Equipments (PPE) to the employees. Employees need to be sensitized for using PPEs. It is imperative to provide proper occupational health and safety training to the workers. Extensive awareness campaign regarding safety measure can help in reducing minor injuries. It was also observed that no occupational health and safety standards prevail in these units.

6.16 Lack of Supply Chain Management (SCM) System

Supply Chain Management (SCM) is another serious problem identified during the study which can provide a sustainable competitive advantage to the agricultural implements manufacturers.

Agricultural implements manufacturers have number of vendors, who provide them various finished and semi-finished parts. This vendor base plays critical role in the quality of final product; manufacturing and delivery time of product as well as per unit cost. Most of the agriculture manufacturers are unaware of the vendor's evaluation criteria and vender's performance evaluation system.

Raw material ordering and re-ordering system is based on conventional methods which results in production delays. Proper prior planning in supply chain management is critical for the success of any business. A breakdown in the supply of raw material / parts can result in diminished sales and credibility of manufacturer.

By establishing proper supply chain, any organization can increase market share by enhancing customers' confidence.

It is therefore recommended that through short trainings, the management of the units can be realized the importance of SCM systems and can capacitate them to develop good SCM by streamlining the vendor / suppliers base.

6.17 Lack of Formal Marketing System

The findings of study reveal that most of the agriculture implements manufacturers lack marketing strategy and marketing infrastructure. Even none of them have well defined marketing department / sales department equipped with trained marketing / sales team. Some of them have dealer's network in some cities, but even these dealers are frequently changed. Proper marketing channels are not well defined along with intermediaries' margins and payment schedule.
At present their sales can be categorized into following:

- ✓ Individual farmer comes to the manufacture usually through some reference or due to word of mouth. Individual farmers usually observe the implements, being used by

farmers in his/her locality. Getting some positive feedback from the user, farmer likes to go to the same manufacturer.

- ✓ Comparatively large sized manufactures keep on manufacture the implements throughout the year, which goes to peak near season of that particular implement-specific crop. All such production is done on the basis of previous year sales pattern, but without any confirmed advance order. Close to season, the finished implements are shipped in lots to dealers based in various cities.

- ✓ Institutional sales to provincial agriculture departments (under subsidy scheme), after getting registered through a pre-qualification process.

- ✓ Institutional sales to various government, semi-government, autonomous and development agencies.

- ✓ Direct export sales or sales to exporters, who in turn complete export orders.

It was also observed that majority of the manufacturing units don't have websites, marketing collateral, and product branding. Moreover, any professional and systematic marketing tools are not used to market the product. Furthermore, the dealers have not been trained by the manufacturers whereby they can give proper orientation or demonstration to the farmers/stakeholders. Related to it, there is no systematic after sales service arrangement, especially during warranty period.

USAID Firms Project may give attention to improve the marketing system of these dealers by enhancing their capacity through soft measures such as training, as well as through hard measures such as developing their websites / web portal and developing linkages between Pakistani exporters and manufacturers or even directly by importers of agricultural implements.

To develop marketing channels, USAID Firms Project can contact agriculture / horticulture / livestock related USAID projects, being executed in third world countries especially in Afghanistan and neighbouring countries to fulfil their demands of agriculture implements. In many such projects, agricultural / horticultural implements and tools are distributed, under grants schemes, to increase per acre yield & quality of crop as well as reducing the harvest and post harvest losses.

6.18 Management Capacity Building and Mindset Change

Besides workers skill enhancement and machines up-gradation, it is equally important to change the mindset of the top management of the agricultural implements manufacturing units whereby they may realize the importance of cost reduction, lead time reduction and various aspects of product and process quality.

The management philosophy is still based on centralization. The top management is not willing to delegate responsibilities to their second in command and like to retain authorities at their own level. Likewise, empowerment to workers is missing. Resultantly top management is involved in micro management and to resolve shop-floor issues rather than focusing on strategic issues and business planning.

It is therefore recommended to impart training to top management in order to change their mind set and management philosophy by exposing them to various modern philosophies and concepts. It is also recommended to organize field visits to the model national and international

organizations which can help them in learning various best practices being adopted by forward looking organizations.

Even better would be to take the opinion leaders of this sector to India or China, who are one step ahead in the technology and management of similar manufacturing units.

7. Sector Development Strategy

In view of the preceding analysis and findings of the agricultural implements manufacturing sector, the following sector development strategy and action plan is recommended.

a) Due to limited time and resources, sector development or cluster development model is not feasible in the given circumstances. In the previous twenty years, many such attempts to develop the entire sector or cluster (of other products) by various development agencies dashed to ground. Even some development agencies opened the common facility centres which are either closed now or striving for their sustainability due to wrong assumptions at planning stage and miss conceived business model. So it is recommended that rather than going for sector or cluster development approaches, better to follow “Individual Units” development approach.

   In agricultural implements manufacturing sector, the competition is intense and if one manufacturing unit goes for any new product or any technological change or modification in design or improvement in manufacturing process then other units do not hesitate to follow the suit, provided they can manage the required financial, human and technology constraints. Sector and manufacturing units are not being managed by well qualified professionals, having international exposure and long term vision but moderately educated businessmen. Such businessmen usually relay more on “seeing is believing” and “emulative behaviour”. So the first pillar of recommended strategy is to go for “Units Development” approach.

b) Select 4-8 manufacturing units in each cluster, taking into account of their motivation, commitment, capacity to absorb changes, and tendency of forward looking.

c) Focus on few specialized implements, based on their sales data, rather than targeting very wide range of products. Focused and targeted intervention can yield better and immediate impact. If we analyze the sales data of the various agricultural implements (Annexure 1), we can conclude that top five[6] most selling implements constitutes more than 80% of the total sales of all of the agricultural implements in Pakistan. The drawings of these selected implements can be got prepared including dies, pattern, etc. Accordingly the manufacturing units can be assisted to develop the standardized production system for these implements.

d) In those implements, where volume can be greater, assembly line approach be introduced by switching from old conventional methods to new lean production approach.

[6] Cultivator, tractor driven trolley, blade, thresher, and ridger,

e) For export markets, exporters of agricultural implements be encouraged and facilitated to pay more attention to finding new markets for their existing products rather than exporting new products.

f) In those implements, where volume can be greater, should opt for assembly line approach, switching from old conventional methods to new lean production approach.
g) For export markets, exporters of agricultural implements should pay more attention to finding new markets for their existing products rather than exporting new products.

h) Productivity and cost competitiveness have attained central place in the new development approaches which are mostly revolved on innovative and entrepreneurial best practices. Innovation and ideas is the driving force of the4 growth and infrastructure, technology and investment have relegated to second position.

i) USIAD Firms Project should contact TEVTA or PVTC to initiate the sector specific vocation training program, which can provide the skilled but productive workforce to this sector abundantly. This initiative would help grow the sector.

j) The common facilities centre (CFCs), managed by SMEDA, TUSDEC, Punjab Small Industries Corporation, PITAC, are offering their services. For the sector development USAID Firms Project should go for some innovative business model, where manufacturing units can avail the services of these CFCs under some feasible arrangement to improve the quality of product and their cost competitiveness.

k) For the sustainability, a resource centre can be established with the partnership of PAMIMA, so that information and literature on the proposed interventions could be available to any manufacturing unit afterwards, who want to follow the suite.

l) On the basis of previous analysis, the following interventions are recommended for the selected units, by clubbing the mentioned gaps.

7.1 Technical Assistance

The project provides the onsite technical assistance to the manufacturing units on the following areas:

- Workshop layout, productivity enhancement, waste control, lead time reduction, cost reduction and other concepts of lean manufacturing.

- Iimplementation of various productivity & Quality tools like, Super 5 S Kaizen, Total Productive Maintenance (TPM) and Quality Control Circle (QCC).

- Product and process standardization

- Material characteristics and material selection

- Welding operations, Machining Operations, Fabrication of implements by on-job training of operators

- Improvement of casting and heat treatment operations

- Business Process Re-Engineering (BPR), whereby the prime objective would be to upgrade existing operations and focus on “Competitiveness”.

- Formation of Cross Functional Teams (CFTs); the prime objective would be to develop teams who can identify improvement areas within the organization, the members will focus on management issues as well as technical problems prevailing in the industry. For tangible improvement in the organization, CFTs members shall be trained for regular assessments whereby they can identify problem areas which lead to continuous improvement. Likewise establishment of Cost Reduction Teams (CRTs): whereby the members would be responsible for reducing cost as well as would focus on lead time reduction through process improvement initiatives.

7.2 Technology and Equipment Upgrades

USAID Firms Project may assist the manufacturing units to upgrade their equipment and machines on cost-share basis. Detailed need assessment of the machinery can be made in consultation with the individual unit. Given the available funds to Project, at least all the welding transformers can be replaced in first go. It would be a great leap towards reduction in cost by using efficient transformer.

7.3 Certification and Standards

If assistance and technical guidance be provided to the units, they can attain ISO 9000 in four to six months. That would help them improve a lot of their operations and help them build their image.

7.4 Benchmarking and Exposure Visits

Exposure visits is very powerful tools to change the mind set and to transform the traditional management philosophy. It is essential that if management of the units personally observe the good manufacturing practices (GMP), in action; they would be more inclined towards adopting them.

7.4 Domestic and Export Marketing Assistance

Project should design the appropriate interventions to provide the following marketing assistance for the improvement of domestic and export sales of the Manufacturer:

1. Website development
2. Public awareness campaign to sensitive the farmers and other buyers about the quality parameters of agricultural implements
3. Export and domestic sales linkages (by developing linkages with local organization and government departments as well as Pakistani exporters and importers of other countries).

4. Regular participation in the international and national exhibitions. Such initiative will promote local implement manufacturers products and would give opportunities to manufacturers to acquire knowledge regarding the latest development.

8. Conclusion

This study has revealed the most pressing needs of the agricultural implements manufacturing sector. In view of the identified gaps, it can be safely said that by applying industrial engineering principles, productivity tools, and management techniques manufacturing units can increase their labor and process productivity significantly, and can cut down their cost by 30% easily. But for this, right approach and correct mind set with commitment of management would be prerequisites.

A systematic program, encompassing modern management concepts, industrial engineering principles, operation and controls, and technology upgrades would be required to roll out in phases. Various consultants with right skill set would be required to place at these units to provide onsite technical guidance on day to day basis. Along with this, technical and managerial training of management, middle management and shop floor workers would be required to increase the capacity of human resources to manage the proposed interventions and to take their organization towards journey of continuous improvement.

The proposed recommendations would have significant implications for the top management of the manufacturing units regarding their future business strategy including investment in capital goods as well as the human resources.

The proposed strategy and interventions would definitely help the professionals of USAID Firms Project to devise appropriate interventions leading to the sector development in a systematic manner with minimum operational and technical risks.

9. Annexes

Annex 1- Top 20 Agricultural Implements in Pakistan in Terms of Number

There are about 1,725,635 agricultural implements in total, being used in Pakistan

Sr. No.	Name of Implements	Number of Implements	Percentage (of Total Implements_
1	Cultivator	516,258	29.9%
2	Trolley	306,437	17.8%
3	Blade	300,933	17.4%
4	Thresher	158,211	9.2%
5	Ridger	101,300	5.9%
6	Seed Drill/Planter	75,976	4.4%
7	Rotavator	68,045	3.9%
8	Mould Board Plough	51,532	3.0%
9	Disk Plough	38,099	2.2%
10	Bar/Disk Harrow	37,002	2.1%
11	Sprayer/Tractor Mounted	22,473	1.3%
12	Chisel Plough	10,305	0.6%
13	Maize Sheller	9,393	0.5%
14	Fodder Chopper	7,773	0.4%
15	Reaper	4,107	0.2%
16	Potato Planter	4,018	0.2%
17	Laser Leveler	3,760	0.2%
18	Potato Digger	2,338	0.1%
19	Sub-Soiler	2,234	0.1%
20	Sugarcane Crusher	2,093	0.1%

Note: The figure has been taken after extrapolation of figures until 2011 of the last “Census of Agricultural Implements of Pakistan”

Annex 2 - Export Potential of Sector (Pakistan Import and Export)

All figures are in US$ Millions

		World				Pakistan			
HS Code	**Product**	**Import**	**Export**	**Leading Importers**	**Leading Exporters**	**Imp of Pak**	**Exp of Pak**	**Leading Exporter to Pak**	**Leading Importer from Pak**
8432	**Agriculture, Horticulture & Forest Machinery**	**5,487**	**5,525**	**USA (585) France (533) Germany (323)**	**Germany (804) Italy (620) USA (563)**	**4.3**	**3.4**	**France (2.6) USA (0.4) Spain (0.4)**	**Nigeria (1.6) Afghanistan (0.5) Tanzania (0.2)**
8433	**Harvesting & Threshing Machinery**	**14,188**	**14,674**	**France (1,456) USA (1,395) Germany (1,346)**	**USA (2843) Germany (2,762) Belgium (1205)**	**17**	**3.8**	**Belgium (5.6) France (2.0) UK (1.3)**	**Afghanistan (2.5) Nigeria (1.0) Tanzania (0.08)**
Total (US$ Million)		**19,676**	**20,199**			**21.3**	**7.2**		

Source: ITC Map

Annex 3 - Business Case for Export - Top ten current importers from Pakistan 2009

Countries	Total Imports US $ (000)	Imports from Pak US$ (000)	Pak Market Share (%)	Regional & Other Similar Competitors Market Share (%) in this Country
Afghanistan		2,986		(detailed data is not available)
Nigeria	36,970	2,685	7.26	China (8.54),India(7.87), Turkey(0.5), Brazil (0.94), South Africa (2.79)
Tanzania	12,100	387	3.20	China (11.72),India,(28.77) Turkey(1.94), Brazil(7.78), South Africa (9.02)
Ghana	3,953	156	3.95	China (2.66),India(28), Turkey(11.97), Brazil(3.97), South Africa(2.66)
Kenya	11,619	138	1.19	China (16.64),India(13.32), Turkey(1.70), Brazil(6.60), South Africa(2.27)
Sri Lanka	10,241	132	1.29	China(30.85),India(26.21), Turkey(0), Brazil(2.74), South Africa(0)
Morocco	71,001	98	0.14	China (.56),India(0.10), Turkey(13.65), Brazil(1.04), South Africa(0)
South Africa	18,0081	94	0.05	China (2.68),India(0.72), Turkey(0.2), Brazil (13.53), South Africa(0)
Sudan	48,282	34	0.07	China (40.82),India(3.10), Turkey(0.74), Brazil(14.38), South Africa (0.04)
Namibia	7,337	7	0.10	China (0.04),India(0.08), Turkey(0), Brazil(33.17), South Africa(36.46)

Annex 4 - Business Case for Intervention (Export) – Potential Countries for Export

Countries	Agriculture Sector Size US$ Million	No of Tractors	Per Capita Income US$	Current Import of Agri Implem US$ (000)	Leading Exporters of Agri Implements to this Country	Pakistan's Market Share %
Nigeria	61,780	30,000	1,223	36,970	China, India, Brazil, Pakistan, South Africa	7.26
Sudan	19,917	11,856	1,510	48,282	Brazil, China, Turkey, India	0.07
Bangladesh	16,442	5,530	563	6,106	China, India, Malaysia,	0.05
Morocco	15,595	49,010	2,519	29,403	China, Pakistan, India, Brazil	0.14
Ghana	10,550	3,600	1,291	3,953	India, China, Brazil, Turkey, South Africa	3.95
Angola	8,102	10,300	4,562	10,044	Brazil, South Africa, China, Lebanon	0.32
Kenya	6,910	12,844	805	11,619	China, India, South Africa, Brazil, Turkey	1.19
Sri Lanka	5,289	10,500	1,971	10,241	India, China, Japan, Vietnam	1.29
Afghanistan	4,490	840	517	4,333	Data not available	68.9

Countries	Agriculture Sector Size US$ Million	No of Tractors	Per Capita Income US$	Current Import of Agri Imp US$ (000)	Leading Exporters of Agri Imp to this Country	Pakistan's Market Share %
Tanzania	9,592	7,600	561	12,100	India, China, Brazil, Pakistan, Thailand, Turkey	3.2
Zambia	3,190	6,000	1,365	11,990	South Africa, China, Brazil, Zimbabwe, India	0
Ethiopia	12,749	3,000	348	18,260	Brazil, China, India, Turkey, Iran	0
Tunisia	4,695	35,100	3,938	23,251	Turkey, Brazil, China, India	0
Namibia	1,095	3,150	5,771	7,337	South Africa, Zimbabwe, India, China, Brazil	0.10
Uganda	4,015	4,700	525	3,715	China, India, Brazil, Turkey	0
Zimbabwe	1,457	24,000	656	4,345	South Africa, China, Brazil, India,	0

Total Current Import of these countries is US$ 243 Million; and mostly of the implements, being manufactured in Pakistan.

Annex 5 - Capacity Need Assessment of One Sample Unit

[redacted]

NAME	Name is not being disclosed		
COMPANY REPRESENTATIVE			
ADDRESS			
TELEPHONE (EXT.)	+92 - -	CELL FAX	+92 - - +92 - -
E-MAIL			

[redacted]
Rotavator

[redacted]
1.Rotavator ◘ 2. _____◘
3. _____ ◘

[redacted]
Pull System ◘ Push System [redacted]

[redacted]

Sr.	Type of Staff	# of employees	Overall Language level *
	TOP MANAGEMENT	2	1 2 3 4
	MANAGERIAL STAFF	1	1 2 3 4
	LOWER STAFF	4	1 2 3 4
	PIECE RATE STAFF	5	1 2 3 4
	CONTRACTUAL STAFF	10	1 2 3 4
	TOTAL EMPLOYEES	22	

[redacted]
[redacted] Light Engineering (Light) any other:
_____

[redacted]

Designing ◘	Rolling ◘
Cutting sharing ◘	Machining (Lathe) [redacted]
Punching/Drilling [redacted]	furnace ◘
Painting [redacted]	Heat Treatment ◘
Casting ◘	Forging ◘
Welding [redacted]	Joining/Assembling [redacted]
Press Working ◘	Fabrication ◘
Bending (Hot & Cold) ◘	Another process :----------

* The Evaluation criteria for Language proficiency:
1. As fluent as the native language (Write and Speak Well)
2. Competent to participate in discussion and express himself.
3. Proficient enough to follow lectures/discussions, but will have difficulties in expressing ideas and giving comments.
4. Cannot speak and write Urdu at all.

[redacted]

ISO 9001:2008 ▫ CERTIFIED [redacted] NOT CERTIFIED ▫ UNDER PROCESS
ISO 14000 ▫ CERTIFIED ▫ NOT CERTIFIED ▫ UNDER PROCESS
OHSAS 18000 ▫ CERTIFIED ▫ NOT CERTIFIED ▫ UNDER PROCESS
4. ANY OTHER (Please mention the standard and the status)

[redacted] Major problems:

Problems of selected department (Please Tick the appropriate one)	
Technology [redacted] Frequent Machine Break Down ▫ Lack training / Lack Skills High cost of production [redacted]	Wastage [redacted] Rework [redacted] Low wages [redacted] Employees Turnover ▫

Item	Main management indices/Benchmarks		Calculation formula	FY 2011-2012	FY 2010-1211	Remarks
GEN		Total Area	--	2000 sq yard		
		No. of units produced	--	On push system		
Productivity		Material	Output/raw materials			No appropriate methods available
		Employees	Output/ Labor hours or employees			
		Machine Maintenance	Output/ Maintenance hours or cost			
		Inventory	Output/Work-In-Process Inventory			
		Waste	Output /process waste	25 %	20 %	
Quality		Scrap	% scrap of raw material	2-4 %	2-4%	
			% scrap of packaging	NA	NA	Not applicable
		Production	% first passed yield	NA		
		Warranty	Warranty period	1 year		
			Customer Return Rate	1-2 %	1-2%	
			# of complaints	1 %		
		Rework	% of Rework	25%	25%	
		Delivery	% mis-delivery	NA		
			% incomplete delivery	NA		
		Product Quality	% of WIP due to quality failure	10-15%	10-15%	

		Machine	% of unplanned equipment downtime	Up to 2%	Up to 2 %	
Timeliness		Supplier Response	% on time from supplier			
		Lead Time/Cycle Time	Cycle time of main product (Order to delivery)	Per piece (Up to 22 days)		
Others		Accidents/Incidents (Machine/Man)	No. of reportable accidents	Not Available		Identified one minor accident
		Employee turnover	% of employee turn over	Over 10%		No appropriate method
		Absenteeism	% of Absenteeism	6 %		
		Overtime	% of overtime	Yes	yes	Data not available

Organizational Data Analysis:

[redacted]

Sr	Model Machine Selection				
1.	Selection of Model Machine (Preferably Worst Machine)	Name	Model	Make	Manufactured year
		NA	NA	NA	NA
2.	Machine Breakdown Time	Total Breakdown time of selected Model Machine in department			Minutes/Month NA
3.	Machine Downtime	Total Downtime of Model Machine in department :			Minutes/Month NA
4.	Machine Defects	Total Number of defects in Model Machine in department :			No. of defects/month NA

[redacted]

(Just tick the appropriate training and also please specify details against each topic, where necessary)[redacted]

ON JOB TRAINING (OJT) REQUIREMENTS	
(In case of Machine Specific Training, Please indicate the type of Machine) Maintenance Process [redacted] Trouble Shooting ◘ Any Other	Instrumentation ◘ Calibration and Monitoring Devices ◘
Maintenance Management [redacted] Any Detail:	Introduction to Computer and Application Software ◘
Industrial Production Planning and Control ◘	Forging/ casting techniques ◘
Inventory Management / Store Keeping ◘	Industrial Machine Tools ◘
Programmable Logic Controllers (PLC) ◘	Industrial Quality Control & Management ◘
CNC Machines ◘	Precision Machining ◘
Design Techniques and Application Software (CAD / CAM)◘	xxi). Machining (Lathe operation) [redacted]
Welding techniques [redacted]	Any other (Please specify) , Drilling
GENERAL MANAGEMENT TRAINING :	
ISO 9000 / ISO 14000 / SA 8000 / Other Standards [ISO9001:2008 ◘	Benchmarking Practices ◘
Enhancing Human Productivity ◘	QC Tools ◘

Productivity Tools ◘	Sales & Marketing [redacted]
Quality Control Circles ◘	Leadership & Motivation ◘
5 S House Keeping Japanese Standards [redacted]	Decision Making & Problem Solving ◘
Integrated Productivity Improvement ◘	Kaizen Management [redacted]
Enhancing Productivity through Total Quality Management ◘	Suggestion System [redacted]
Total Productive Maintenance (TPM) [redacted]	xvi). Occupational Health & Safety (OHAS) [redacted]

ANY OTHER SPECIALIZED TRAINING REQUIRED:

_____

_____

_____ [redacted]Organizational Level Survey- 1 Mission, Vision and Goals/Objectives

Vision/Mission:	To compete global market and introduce new features in the product for achieve customer satisfaction.
Quality Policy:	Not Available (Not Available)
Business Goals/Objectives (Long/Medium Term business plan	To introduce latest technology from designing, development and manufacturing of the Rotavator. Technological up-gradation of the current machines/ facilities by 2015 To develop direct linkages with international buyers with the mandate to enter in the export market To introduce new agriculture implements in market. To manufacture quality product and enter into the export market by year 2015.
Business Goals/Objectives (Short Term business plan	To enhance sales turnover, selling more than 500 units per year. To reduce wastages from 25% to less than 10% by 2014. To reduce rework due to workers negligence from 4% to 1 % by 2013. To reduce machine setup time from 5% to 1 %.

a) Organizational Level Survey-2 SWOT Analysis

Parameters	Strengthen	Weakness	Opportunity	Threats
Manpower	Management commitment Hands on experience	Employees motivation Un skilled labor Low wages Absentisium Employee turnover	Transformation from manual worker to knowledge worker Capacity enhancement opportunities .	Skill base needs up-gradation to adapt new techniques
Machines	Availability of all machines as per the process.	Obsolete Technology available for manufacturing Old machines Higher setup time Machine downtime Minor stoppages	Preventive maintenance with zero breakdown philosophy**.**	Technological advancement
Material		High cost of raw material Inconsistent raw material prices Work in process inventory (WIP) losses, High rejection of Casted components (up to 25% Raw material Wastages) Non availability of quality raw material	Due to competition material available may be cheaper.	Price fluctuation of raw material
Methods	Old conventional method of production/ processes	Workshop Layout Operating on push system rather than pull.		
Measurement/QA/QC		Lack Quality control system Lack Quality Assurance System Lack calibration for measuring equipment		
Miscellaneous	Strong presence in the domestic market	Seasonal business Lack standardization Narrow product range Brand management No sophisticated marketing strategies Dealers credit Farmer lack knowledge regarding agriculture implements Lack innovation Lack new product development	Potential and Possibility of export. Proper branding with active participation in international exhibition Quality and productivity are keys to success.	Electricity shortfall.

b) Organizational Level Survey-3 Need Analysis

Present/Actual Needs:	Workshop layout development Infrastructure development Availability of skilled labor Availability of quality raw material at low cost Standardization Cost Reduction, process improvement and lead time reduction.
Present/Potential Needs	Branding Marketing strategy Ability for mass production Direct access to international market
Future Actual Needs	Strengthen Research & Design Up gradation of machines Participation in international and national exhibitions
Future Potential Needs	Automation or Autonomation Technological change Access to International buyers/market

Annex 6 - Major Training Contents for Welders, Machinist, and Fabricator on-Job Training

Welders

- Welding Safety (Apply safe work practices and procedures when using welding and cutting equipment)
- Weld Faults (Identify the cause of faults in welds and methods for their prevention)
- Materials Handling (Apply safe materials handling procedures)
- Basic Joint and Weld Types

    1. Identify the five basic joints.
    2. Describe the types of welds and their acceptable dimensions.
    3. Identify joint and weld type variations.
    4. Outline the major considerations to be accounted for in the design of a joint for welding.

- Welding procedure
- Arc Cutting and Gouging
- Equipment Maintenance and Troubleshooting
- Solder and braze various sheet metal projects with maximum safety
- Most common problems of welding, which cause rejection / rework (causes and remedial measure)

Machinist

- Basic Measurement Tools
- Precision Measuring Tools
- Angular Measuring Tools
- Inspection Gauges
- Non-Cutting Hand Tools
- Hand-Held Cutting Tools
- Screw Thread Terminology
- Screw Thread Measuring and Gauging
- Taper Systems
- Machine Lubrication and Cutting Fluids
- Hand Grinding Machines
- Drilling Machines
- Types of Lathes
- Speeds, Feeds and Cutting Tools
- Lathe Operations

    1. Set-up the cutting tool to perform parallel turning and boring operations.
    2. Operate a lathe to turn a shoulder.
    3. Perform center drilling, drilling and reaming operations.
    4. Set-up a lathe to cut tapers.
    5. Perform knurling, grooving, parting-off, forming and profiling, in the lathe.
    6. Use taps, dies, and a single point tool to cut a thread.
    7. Describe the use of steady rests, follower rests, and mandrels on the lathe.

8. Follow safety guidelines when performing finishing operations in the lathe

- Power Saws and Cut-off Machines
- Metallurgy (select the right material)
- Most common problems of machining, which cause rejection / rework (causes and remedial measure)

Fabricator

- Measuring, Marking, Cutting and Striking
- Machine Tools
- Know the physical properties, manufacturing process and application of ferrous and non-ferrous metals in common use
- Understand workshop safety rules and application in machine shop
- Understand the working principles of a drilling machine, use it to drill and ream holes on metals and other engineering materials

- Understand the applications of various types of screw threads, rivet and cut screws by hand
- Understand the ISO tolerances and fits and its application in engineering Production
- Apply Appropriate Workshop Processes, Techniques And Tools To Mark Out, And Form Projects In

USAID Firms Project
info@epfirms.com